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Management of microcircuit obsolescence in a pre-production ACAT-ID missile program

Pearce, William S.

Monterey, California. Naval Postgraduate School

NAVAL POSTGRADUATE SCHOOL
Monterey, California

THESIS

MANAGEMENT OF MICROCIRCUIT OBSOLESCENCE IN A PRE-PRODUCTION ACAT-ID MISSILE PROGRAM

by

William S. Pearce

December 2002

Principal Advisor:	David F. Matthews
Associate Advisor:	Amy J. Grover

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Microelectronic piece-part component obsolescence problems are prevalent and costly across all Department of Defense (DoD) weapon systems, both new and legacy. The issue is driven by the high turnover in electronic components, limited DoD influence upon component manufacturers, poor obsolescence management at both Program Office and Command levels, and a lack of understanding of the analysis tools and design techniques available to the Program Manager (PM) to help mitigate problems. The issue of microcircuit obsolescence affecting a pre-production, Acquisition Category (ACAT)-ID, Missile program is of particular interest due to their inability to transition from pre-production into full rate production, without a major redesign due to microcircuit obsolescence. The DoD and other Governmental agencies, along with commercial industries, are investigating numerous ways to reduce the increasing costs associated with obsolescence. This thesis incorporates this information to provide both the pre-production ACAT-ID Missile Weapon System Program Managers and the U.S. Army Aviation and Missile Command (AMCOM) guidance in addressing microcircuit obsolescence challenges from a management perspective

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MANAGEMENT OF MICROCIRCUIT OBSOLESCENCE IN A PRE-PRODUCTION ACAT-ID MISSILE PROGRAM

William S. Pearce
DB-3, Department of the Army
B.S., University of Alabama in Huntsville, 1992

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requirements for the degree of

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December 2002

Author: William S. Pearce

Approved by: David F. Matthews
Principal Advisor

Amy J. Grover
Associate Advisor

Douglas A. Brook, Ph.D.
Dean, Graduate School of Business and Public Policy

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ABSTRACT

Microelectronic piece-part component obsolescence problems are prevalent and costly across all Department of Defense (DoD) weapon systems, both new and legacy. The issue is driven by the high turnover in electronic components, limited DoD influence upon component manufacturers, poor obsolescence management at both Program Office and Command levels, and a lack of understanding of the analysis tools and design techniques available to the Program Manager (PM) to help mitigate problems. The issue of microcircuit obsolescence affecting a pre-production, Acquisition Category (ACAT)-ID, Missile program is of particular interest due to their inability to transition from pre-production into full rate production, without a major redesign due to microcircuit obsolescence. The DoD and other Governmental agencies, along with commercial industries, are investigating numerous ways to reduce the increasing costs associated with obsolescence. This thesis incorporates this information to provide both the pre-production ACAT-ID Missile Weapon System Program Managers and the U.S. Army Aviation and Missile Command (AMCOM) guidance in addressing microcircuit obsolescence challenges from a management perspective.

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LIST OF ACRONYMS

ACAT-ID	Acquisition Category
ACME	Application of Commercially Manufactured Electronics
AIAA	American Institute of Aeronautics and Astronautics
AMC	Army Materiel Command
AMCOM	Aviation and Missile Command
AMRDEC	AMCOM Research Development and Engineering Center
ASIC	Application Specific Integrated Circuit
AVCOM	Avionics Component Obsolescence Management
BRU	Battery Replaceable Unit
CAIV	Cost as an Independent Variable
CAPS	Computer Aided Product Selection
CAS	Commercial Avionics Systems
CCA	Circuit Card Assembly
COTS	Commercial Off the Shelf
DLA	Defense Logistics Agency
DMEA	Defense Micro-Electronics Agency
DMS	Diminishing Manufacturing Sources
DMSMS	Diminishing Manufacturing Sources and Material Shortages
DoD	Department of Defense
DUSD(L)	Deputy Under Secretary of Defense for Logistics
ECP	Engineering Change Proposal
ECU	Environmental Control Unit
EIA	Electronic Industry Association
ELES	Enhanced Launcher Electronics System
EMD	Engineering Manufacturing and Development

FAA	Federal Aviation Administration
FFF	Form-Fit-Function
FMS	Foreign Military Sales
FPGA	Field Programmable Gate Array
GBI	Ground Base Interceptor (formally NMD)
GIDEP	Government-Industry Data Exchange Program
HDL	Hardware Descriptive Language
IC	Integrated Circuits
IEC	International Electro-technical Commission
IEEE	Institute of Electrical and Electronics Engineers
IHS	Information Handling Services
IMMC	Integrated Material Management Center
IPPD	Integrated Product and Process Development
IPT	Integrated Product Team
JEDMICS	Joint Engineer Data Management Information Control Systems
LOT Buy	Life of Type Buy
LTPO	Lower Tier Project Office
LRIP	Low Rate Initial Production
MDA	Missile Defense Agency
MFG	Master Frequency Generator
MEADS	Medium Extended Air Defense System
MTI	Manufacturing Technology Incorporated
MTS	Modernization Through Spares

NMD	National Missile Defense
NRE	Non Recurring Engineering
NSN	National Stock Number
O&S	Operating and Support
OEM	Original Equipment Manufacturer
OLAP	On-Line Analytical Processing
OLDP	On-Line Transaction Processing
OPT	Obsolescence Prediction Tool
OSD	Office of the Secretary of Defense
PAC-3	Patriot Advanced Capability modification 3
PEMS	Plastic Encapsulated Microcircuits
PM	Program Manager
PMO	Program Management Office
PMP	Part Materials and Processes
PPO	PATRIOT (Missile System) Project Office
PPU	Prime Power Unit
QSL	Qualified Source List
RFDL	Radio Frequency Data Link
RFP	Request for Proposal
SBIR	Small Business Innovative Research
SCD	Source Control Drawing
SDD	System Development and Demonstration
SDW	Shared Data Warehouse
SME	Subject Matter Experts
SOO	Statement of Objectives
SOW	Scope of Work
SPI	Single Process Initiative

TACOM	Tank-Automotive and Armaments Command
TACTech	Transition Analysis Component Technology
TACTRAC	TACTech/Research Analysis Corporation
TDP	Technical Data Package
THAAD	Theater High Altitude Area Defense
TTDB	Technology Trends Database
US	United States
USC	United States Code
VHDL	VHSIC Hardware Description Language
VHSIC	Very High Speed Integrated Circuit
VPSB	Virtual Parts Supply Base

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I. INTRODUCTION

A. PREFACE

Microelectronic piece-part component obsolescence is prevalent and costly across all weapon systems, both new and legacy. The issue is driven by the high turnover in electronic components, limited Department of Defense (DoD) influence upon component manufacturers, poor obsolescence management at both the Program and Command levels, and a lack of understanding of the analysis tools and design techniques available to the Program Manager (PM) to mitigate problems. The DoD and other Governmental agencies, along with commercial industries, are investigating numerous ways to reduce the increasing costs associated with obsolescence. The proposed research will incorporate this information to provide both Acquisition Category (ACAT)-ID Missile Weapon System Program Managers and the Aviation and Missile Command (AMCOM) guidance in addressing microcircuit obsolescence from a management perspective.

B. RESEARCH OBJECTIVE

This research will evaluate the various design techniques, analysis tools, management initiatives, programs, and plans, available to mitigate obsolescence relative to a pre-production ACAT-ID missile weapon system. The research will consist of the analysis and review of the different mitigation approaches available to missile weapon system ACAT-ID Program Managers.

C. RESEARCH QUESTIONS

1. Primary Research Question

- From a missile weapon system, pre-production, and an ACAT-ID missile Program Manager's perspective, what tools, analysis, and program directives can be implemented to mitigate cost and schedule impacts due to microcircuit obsolescence?

2. Subsidiary Research Questions

- What market forces are causing a new ACAT-ID missile weapon system program, with a new design, to be vulnerable to obsolescence?
- What are the current methods being used in ACAT-ID missile programs to detect and mitigate microcircuit obsolescence?

- What is commercial industry doing to mitigate microcircuit obsolescence issues and how can commercial practices be leveraged to apply to military programs?
- What are the tools currently available to mitigate microcircuit obsolescence, how can they be optimized, and what are their shortcomings with respect to microcircuit obsolescence issues?
- How can the missile weapon system, ACAT-ID missile Program Manager plan for microcircuit obsolescence?
- How can the AMCOM Research, Development, and Engineering Center (AMRDEC) be utilized to support the missile weapon system ACAT-ID Program Manager?
- What DoD initiatives are in place to address obsolescence issues at a Service level?
- What policies and programs can DoD or a major command, such as the Aviation and Missile Command (AMCOM), implement to assist the missile weapon system ACAT-ID Program Manager?

D. SCOPE OF THE THESIS

The scope of the thesis will include 1) an analysis of the market forces affecting the high rate of obsolescence issues associated with modern military weapon systems; 2) an evaluation of the present obsolescence mitigation strategies; 3) an evaluation of the available design tools and analysis techniques available to mitigate obsolescence; 4) a critical analysis and recommendations concerning how the AMCOM Obsolescence Group can be structured to better support the missile weapon system ACAT-ID missile Program Managers; and 5) an implementation guide for pre-production missile ACAT-ID weapon systems. The study will include impacts/opportunities for Program Managers, DoD, and AMCOM, relative to the management and mitigation of obsolescence. The thesis, broad in scope, will include guidance and will focus on management approaches applicable to missile weapon systems.

E. METHODOLOGY

The methodology used in this thesis research will consist of the following steps.

- Conduct a comprehensive literature search of books, magazine articles, CD-ROM systems, Government reports, internet-based materials, and other library information resources.
- Conduct interviews either in person, or by telephone, with acquisition professionals and functional area experts at AMCOM, DoD, and other

Government agencies and commercial companies in order to develop a full understanding of program issues and objectives.

- Collect cost-benefit and trade-off analysis data from obsolescence Subject Matter Experts (SME) and commercial obsolescence analysis vendors.
- Conduct a cost-benefit analysis in order to assess and prioritize obsolescence analysis tools, and design techniques, against long-term requirements for modernization. Likely measures of costs include dollar expenditure, time to develop and field solutions, and any increased infrastructure and support requirements. Likely benefits include increased obsolescence capabilities, greater efficiency, reduced life-cycle support costs, and greater avoidance of cost and schedule impacts due to obsolescence.

F. BENEFITS OF RESEARCH

The benefits will be cost-benefit and trade-off analyses with fiscal, technical, and business considerations that provide a pre production ACAT-ID Missile weapon system Program Manager with a cohesive obsolescence strategy. Recommendations for obsolescence assistance from the AMCOM Obsolescence Group will also be addressed.

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II. BACKGROUND

Diminishing Manufacturing Sources and Material Shortages (DMSMS), what is it? What is the difference between DMSMS and obsolescence? Why has obsolescence been such a problem? When it comes to how DMSMS and/or obsolescence affect the development program, the result is the same. The needed component cannot be economically procured. The Department of Defense (DoD) uses the term obsolescence as a subset of DMSMS. The DoD defines DMSMS as the loss or pending loss of manufacturers or suppliers of items or raw materials due to the discontinuance of production.[1] Obsolescence is the inability to procure or obtain the device needed. Obsolescence can occur in any phase of a program, whether early in design, System Development and Demonstration (SDD), or a legacy system. Obsolescence can affect any part of the program. Obsolescence has the potential to severely affect the program or some type of end item in terms of both schedule and cost.

The majority of obsolescence problems occur in the area of electronic components; and within the electronic components category, primarily microcircuits (i.e. integrated circuits). For the purpose of this report, the concentration will be on the management of electronic piece-part components in an Acquisition Category (ACAT)-ID pre-production program. Obsolescence problems influence more than just piece-part components. They can include obsolescence at the part, module, equipment, or other indenture level of the system element. In order to understand the impact of electronic component obsolescence, it is first worth looking at the background of the issue of component obsolescence in military systems.

The DoD is not the only major sector that considers obsolescence a serious issue. The airline industry, the automotive industry, and other large industries also consider, or already have obsolescence as a serious problem.

Through increased reliability for weapon systems, military weapon systems have had their system life cycle lengthened, which has decreased the demand on the for manufacturers to produce products, resulting in companies leaving the DoD

1 DoD 4140.1-R; DoD Materiel Management Regulation; (Updated 24 July 2001), Section C1.4.1, May 1998.

manufacturing business for commercial endeavors. With fewer manufacturers, and rapid advancements in technology, DoD has experienced shortened electronic component lifecycles.

Many of the early, post solid-state technology, military systems had a lifecycle between 15 to 20 years. The length of lifecycles for military weapon systems has been coupled with the challenges of rapid advances in technology. Components that used to have a lifecycle of 10-20 years, now have a lifecycle of only 3-5 years due to changing evolving technology. This is particularly true in the case of microcircuits, where the lifecycle of an integrated circuit is anywhere from 18 to 24 months. This decrease is particularly acute for the electronic components discussed earlier. There is considerable concern in the DoD revolving about the cost of future obsolescence problems. The Deputy Under Secretary of Defense for Logistics (DUSD(L)) indicates that the average cost to redesign a typical circuit card to eliminate obsolete components is $250,000. The Electronic Industry Association (EIA) manufacturing operation and technology committee reported a cost range for redesign of between $26,000 and $2 million.[2]

What are the driving market forces behind current military piece-part and component obsolescence problems? Actually, there are two main driving forces. One of the driving factors is the turnover in electronic technology. The other is the amount of piece-part electronic components bought by the DoD as a function of the total electronic component industry output. About 15 years ago, the DoD bought about 25% of the total electronic piece-parts produced, these are primarily the integrated circuits (ICs) made by industry. Today the DoD purchases about ½ of 1% of the total market. The DoD has lost its volume leadership. Along with losing its volume, it lost the ability to influence the direction the industry is going to take.

2 Defense Electronics Agency, Program Managers Handbook: Common Practices to Mitigate the Risk of Obsolescence, May 31, 2000.

DECLINING MILITARY PRESENCE

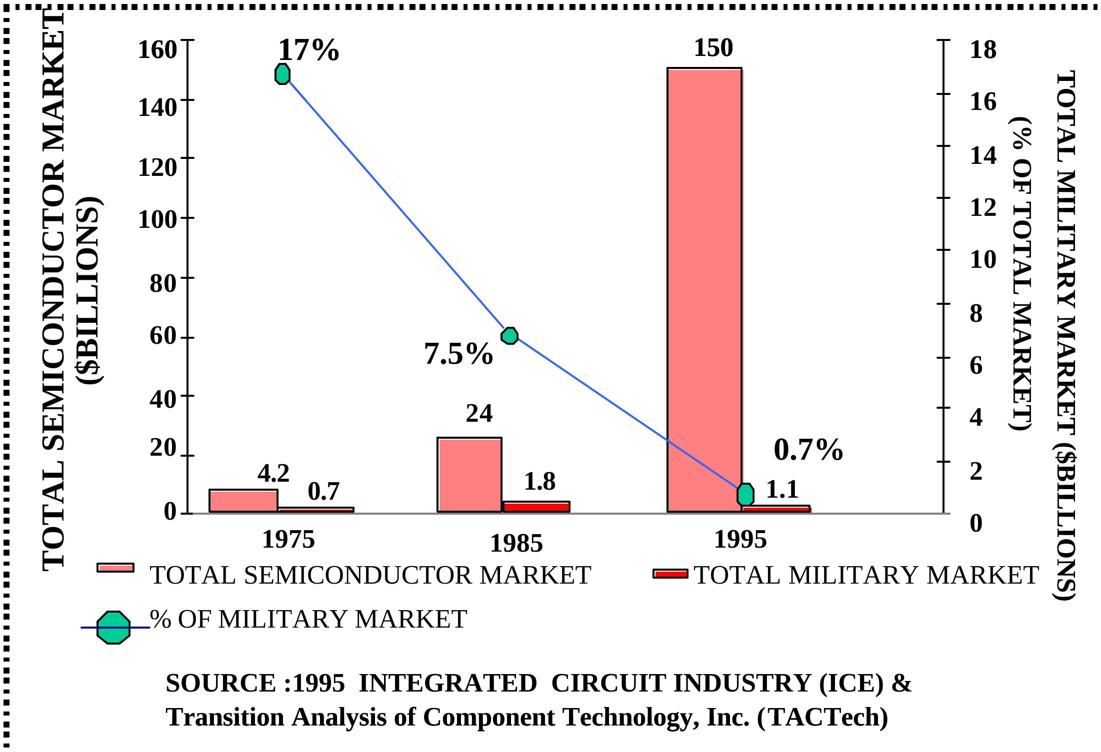


Figure 1. Declining Military Presence.

This can be reviewed in Figure 1 above. Again the turnover in technology, as discussed earlier, is also a function of military weapon systems acquisition practices; it takes seven to ten years to take a system from a concept exploration into initial fielding. In those seven to ten years, electronic piece-part components have turned over four or five times due to the present 18 to 24 month turnover in microcircuit technology. This quick turnover can be seen across the commercial spectrum from desktop computers to cell phones, to VCRs, to digital cameras. These types of commercial industries are pushing market technology. This same turnover in technology is hampering DoD's ability to manage the electronic components obsolescence problem.

Computer	**54%**
Communications	**17%**
Consumer	**15%**
Industrial	**9%**
Auto	**4%**
Military	**<1%**

0.3% (2001)

Same for Commercial Air

SOURCE: ***ICE TACTech***

Figure 2. Use of Electronic Components.

By taking a look at some of the missile programs that the Missile Defense Agency (MDA) administers, such as Theater High Altitude Area Defense (THAAD), Ground Based Interceptor (GBI) formally National Missile Defense (NMD), and the Patriot Advanced Capability modification 3 (PAC-3) as well as some other missile programs in the pre-production life-cycle phase, critical obsolescence issues can be evaluated. Along the same lines as the commercial industry pushing technology, is the decrease in power that microcircuits are using in today's industry. Years ago, the standard for all industry, whether military or commercial, was five volts. Over the past five years advances in technology have enabled the use of less power-consuming components. While commercial industry has picked up on these lower-power, less voltage components, the military, with its long lifecycle needs, has tried to maintain its five-volt technology.

In New Commercial Design Starts

YEAR	5V	3V to 5V	3.0 - 3.5V	<3V
1990	100%			
1991	98%	2%		
1992	93%	5%	2%	
1993	85%	8%	6%	1%
1994	77%	19%	12%	2%
1995	46%	26%	22%	3%
1996	36%	19%	33%	12%
1997	28%	16%	39%	17%
1998	21%	12%	42%	25%
1999	15%	9%	44%	32%
2000	9%	6%	40%	45%
2001	5%	4%	33%	58%
2002	2%	3%	29%	66%
2003		2%	25%	73%
2004			22%	78%
2005			16%	84%

SOURCE: Jim Martin "3V REVOLUTION" with modifications

Figure 3. Power and Voltage Components.

The military is left with still having to support its old five-volt technology designs. Naturally, commercial industry, the vendors of these microelectronic devices, is concerned with profits. As discussed above, the DoD currently comprises less then 1% of the total microcircuit market. At less than 1% of the microcircuit market, the profits realized by the commercial companies developing these components for DoD are minuscule. The commercial companies look at their profit structure and realize they can delete what would be unprofitable military lines in favor of more profitable commercial lines.

Formerly, there were many manufactures that made military-grade microcircuits, mainly along the lines of the ceramic-type devices. The commercial industry uses a little less power and does not have the temperature extremes required by the military market. Plastic commercial parts are now, by default, becoming the standard for the military market. The ceramic devices that have the ability to maintain the desired temperature and long shelf-life requires maintaining commercial manufactures of the silicone wafers and dyes that go into the packaging of these electronic devices. A decision concerning maintenance of this capability has to be made. Decisions by the commercial industry are driven by profit and require analysis of whether packaging of military devices is going to cover their cost. Many manufacturers have therefore discontinued military lines. Some have even discontinued all military products; most notably Motorola, which back in 1992, eliminated its entire military product line. Over the last few years, Harris Semiconductor has also discontinued many of its military-grade commercial products. Some of these manufactures may maintain the same commercial device, but the cost associated with military requirements has not been sufficient for them to continue to manufacture military versions of these devices.

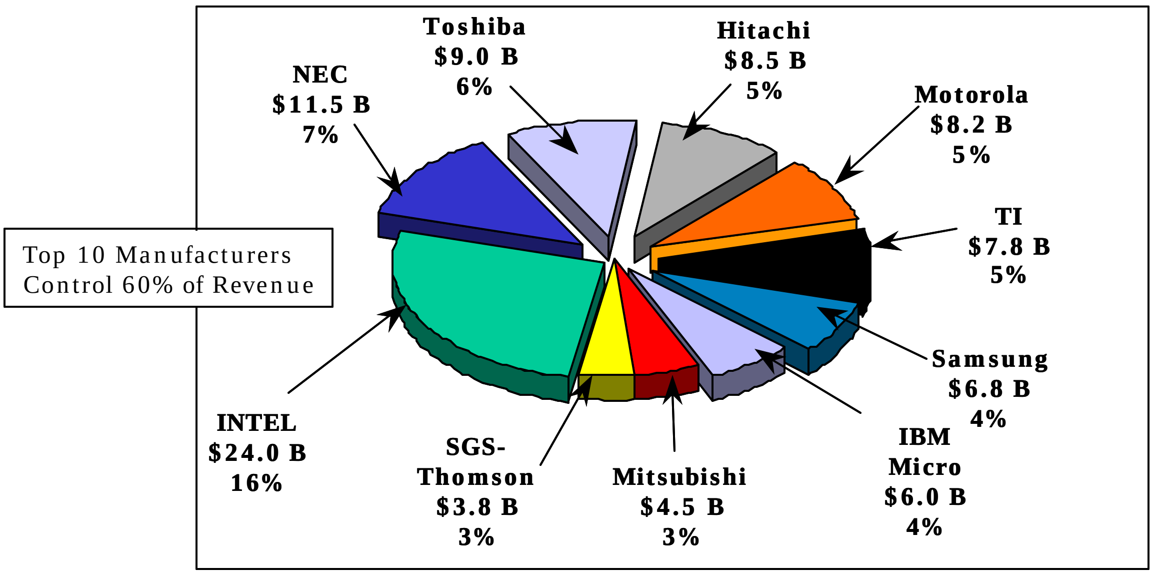


Figure 4. Manufacturers of Semiconductor Devices.

As seen in Figure 4 above, the top 10 manufactures of semiconductor devices make up 60% of the sales. Many of these companies, such as Intel and Motorola, no longer manufacture military-grade devices. The trend to discontinue military devices is expected to continue to increase in the future.

III. CURRENT METHODS OF ADDRESSING COMPONENT OBSOLESCENCE AND THE EVALUATION OF THE INSTITUTED PROGRAMS

A. AMCOM RESEARCH DEVELOPMENT AND ENGINEERING CENTER OBSOLESCENCE PROGRAM

The Army AMCOM obsolescence group was formed in the late 1980's to address electronic piece part component obsolescence as these issues had begun to significantly impact programs. This obsolescence group previously fell under the Engineering Directorate, Industrial Operations Division, AMCOM Research Development and Engineering Center (AMRDEC). The obsolescence effort is a functional part of the Industrial Base Group, the Industrial Operations Division, and continues today. Obsolescence is funded through the Army Materiel Command (AMC) at a level at which the Industrial Operations Division can track various companies that are key to the continued manufacturing of components for the Department of Defense. The AMC obsolescence effort will be discussed in a later section. In 1998, during a reorganization, the analysis of the industrial base remained in the Industrial Operations Division, and the AMCOM Obsolescence Group merged with the Manufacturing Science and Technology Division of the Engineering Directorate. Officially, the AMCOM Obsolescence Group became the Electronics Analysis and Prototyping Group.

The Electronics Analysis and Prototyping Group is funded directly by the requiring program offices. No outside funds are received beyond that provided by the Program Management Offices (PMOs). The group receives funding from multiple PMOs at Redstone Arsenal. When the group is initially funded by a Program Office, its first tasking is to create a component obsolescence program within the PMO. Through this process the Electronics group can educate the PMO concerning its capabilities and provide the latest information regarding component obsolescence. Once a particular program funds the group, it acts on that program's behalf as a subject matter expert in the field of component obsolescence. The group strives to form a Working Integrated Product Team (WIPT), or partnership, of some type, with the prime contractor who is ultimately responsible for building a particular weapon system. The group, as a result of acquisition reform, has changed its processes. It is no longer a driving force able to mandate that the prime contractor perform various activities, but now must influence the contractor through the use of ***best practices*** when it concerns a component obsolescence program.

The group maintains a master database of all the piece-part electronic components from various programs the group supports. The group converts the program-specific part number to the manufacturer's part number. An obsolescence analysis and lifecycle assessment is then constructed on each component in the database. The group has a variety of obsolescence analysis tools, both Government and commercial, to assist in this obsolescence evaluation effort. Some of the tools used by the Electronics Analysis and Prototyping Group are as follows:

Tool	**Purpose**
Government/Industry Data Exchange Program (GIDEP)	Obsolescence Alert Monitoring Notification System
Joint Engineer Data Management Information Control Systems (JEDMICS)	Engineering Drawing Repository
Defense Logistics Agency/Defense Supply Center Columbus Database	Microelectronic Inventory Information
Army Information System	Automated GIDEP Alert Notification System
Integrated Material Management Center (IMMC)	Army Supply Inventory, Usage and Cost Data
PSPICE	Electronic Circuit Modeling/Simulation Analysis Information Tool
Total Parts Plus	Weapon System Configuration Management Tool With Microelectronics Die Tracking for Obsolescence
Transition Analysis Component Technology (TACTech)	Semiconductor/Electronic Piece Part Obsolescence/Availability Life Projection
Information Handling Services	Technical Engineering and Logistics Information Tool

Table 1. Obsolescence Analysis Tools. (From: AMCOM Electronic Analysis and Prototype Group)

The use of the manufacturer's part number makes it possible to analyze the components against the manufacturer independently from the program for which the component is used. The group has developed a process to address obsolescence issues as seen in Figure 5.

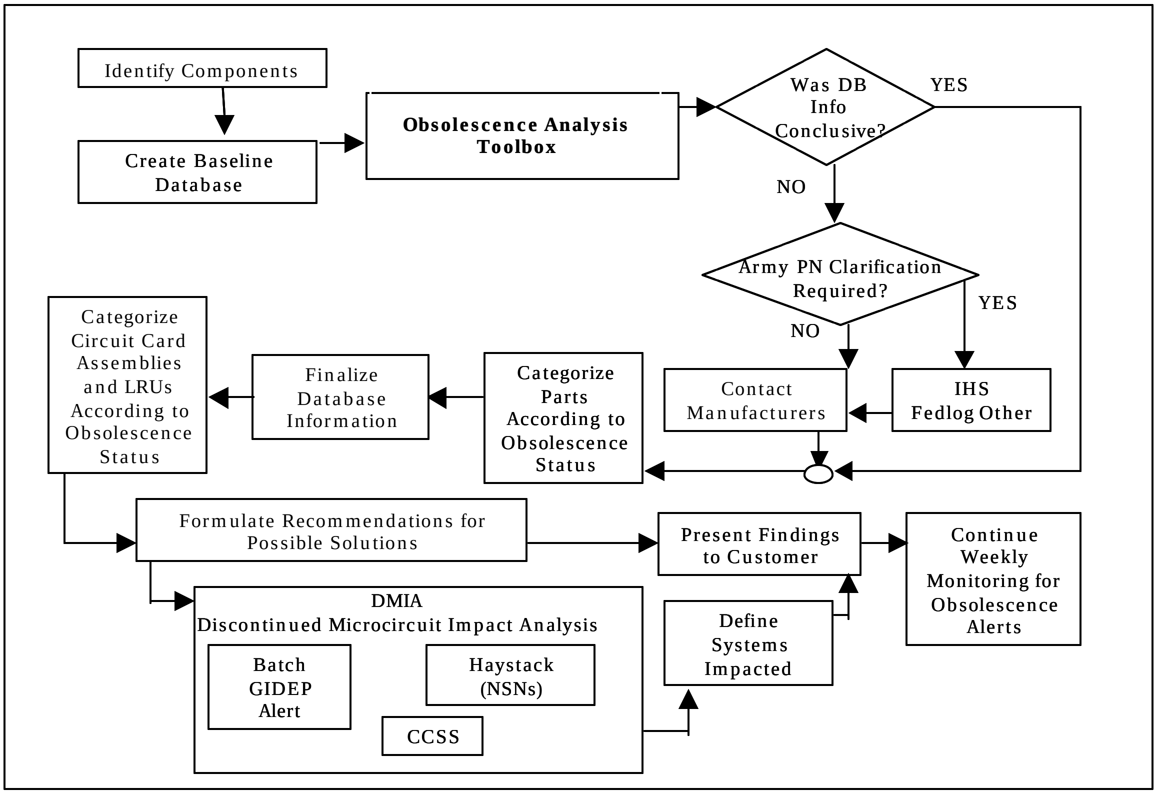


Figure 5. AMCOM Electronics Analysis and Prototyping Group - Obsolescence Analysis Process (CHART).

The group uses an obsolescence rating system for management and program level assessments. A RED, YELLOW and GREEN system is used as follows for piece-part components:

RED	The piece-part currently has no available manufacturing sources
YELLOW	The piece-part has only one manufacturing source or is a sole source device
GREEN	The piece-part has two or more manufacturing sources. No End-of-Life issue.

Table 2. Component Obsolescence Codes.

The group uses a variation of the RED/YELLOW/GREEN approach to associate the obsolescence status of a circuit card assembly (CCA). A solution might be more economical at the CCA level, rather than using individual component solutions, if multiple components are obsolete. Thus, the RED/YELLOW/GREEN approach is utilized to simplify the data and provide program management with a quick and easy indicator of high-risk areas.

RED	CCA has at least one RED component
YELLOW	CCA has at least one YELLOW component and no RED components
GREEN	CCA has all GREEN components

Table 3. Obsolescence Code of CCAs.

The group has developed an approach to show the obsolescence status visually on a circuit card. This visual aid assists in educating the PMO on the obsolescence status on the circuit card and the PMO can immediately see the obsolescence status of the CCA.

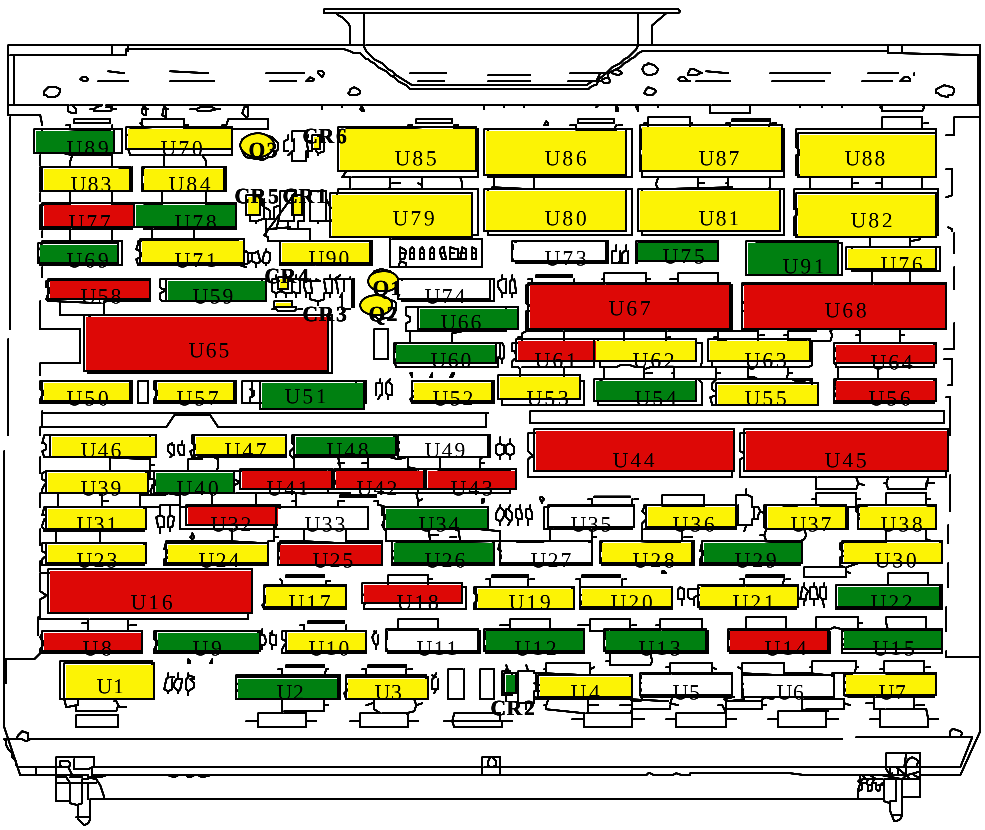
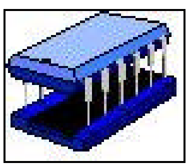


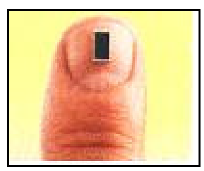
Figure 6. Obsolescence Status on a Circuit Card.

Based on the output of the obsolescence analysis, the group develops a resolution. Each resolution has a cost associated with its implementation. For an obsolete component, the group developed the following table of solutions for obsolescence issues.

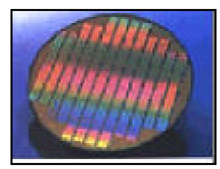
No Action	Sufficient Inventory to Support Demand
Substitute	Form, Fit, Function, (FFF) Compatible with Original Device (e.g., Integrated circuit, transistor, diode).
Substitute with Screening	Generally a FFF Commercial Off the Shelf (COTS) part that needs to be tested or up-rated for the desired environment.
Aftermarket Package	The Die is available and can be packaged by an aftermarket supplier (e.g., Rochester, Lansdale).
Aftermarket Manufacture	The Wafer has to be manufactured first, then packaged by an aftermarket supplier.
Life of Type (LOT) Buy	Buy enough inventories to meet all future requirements.
Emulation	Manufacture of a FFF replacement through reverse engineering.
CCA Redesign	Board or system has to be redesigned since no other cost effective resolution exists.



Integrated Circuit



Die



Wafer

Table 4. Solutions for Obsolescence Issues.

Once the assessment is completed, the group can will report the findings to the program office in either a written report, briefing, or verbally, on the status of the PM's system. The group, at the discretion of the PMO, also transmits the same report to the prime contractor.

The group interfaces directly with the AMC DMSMS/Obsolescence Group for Army policy and procedures, and disseminates that information to the various programs resident at AMCOM. The group is teamed with the DoD Diminishing Manufacturing Sources and Material Shortages Teaming Group to aid in the proactive identification of obsolescence issues across multiple weapon systems and to assist in finding resolutions.

The group assists in evaluating components in the design stage. It is at this stage that decisions have the greatest impact upon the total lifecycle support of the program. The group influences the design so that it is sufficiently robust so that when obsolescence issues occur, resolutions can be more easily implemented into the program. The group influences the design by advocating a design technique called flexible foot-printing. This approach entails multiple component packages that can be used as long as the components function the same. Other design techniques include ensuring that the latest commercial industry interface standards are used for open architecture. Very High Speed Integrated Circuit (VHSIC) Hardware Description Language (VHDL) modeling is used whenever possible, and components with multiple manufacturing sources are employed. The practice of using the same design as in the past, just because it was previously successful, is discouraged. Analysis should ensure that the newest technology has a mature manufacturing base before being implemented into the program.

B. COMMERCIAL INDUSTRY MITIGATION OBSOLESCENCE PROCESSES

A good industry to compare an ACAT-ID missile program with is the airline industry. A comparison can be made on how the airline industry handles obsolescence issues versus how an ACAT-ID missile program handles the issue. Boeing, the largest manufacturer of commercial aircraft in the United States (US), has been addressing these issues since the early 1990's, and has developed a management plan to address obsolescence within Boeing's commercial business sector.

In addressing the obsolescence mitigation issues, Boeing has broken the problem down into five categories for management to address.

- Scope of Components Obsolescence
- Selection of Management of Electronic Components
- Design of Electronic Systems and Equipments
- Operation, Maintenance, and Support of Electronic Equipment
- Qualification and Certification of Electronic Equipment

1. Scope of Components Obsolescence

The first management area is to obtain a full analysis of the obsolescence issue. Boeing estimated that 60% of integrated circuits currently in aerospace will be obsolete, and out of production, within five years.[3] In 1984, Boeing estimated the aerospace and defense supply chain procured about 7% of the total consumption of microelectronic components. By 2000, the aerospace and defense supply chain procured 0.3% of the electronic components. Within the total electronic components market, the aerospace industry procured less then 0.1% of the roughly $25 billion annual microprocessor sales from Intel.[4] With the purchase of only 0.1% of their microprocessor output, there is not enough market strength to influence a major components manufacturer to maintain a production line in order to mitigate obsolescence.

The estimate that 60% of the integrated circuits will be obsolete within five years will profoundly impact component turnaround in the aerospace industry. The major assemblies containing these components have a life cycle of 20-30 years. The rapid turnaround in components, due to obsolescence, greatly affects how the aerospace industry handles these components and the technology in their designs. As depicted in Figure 7, aircraft built in 1975 used electronic components that had a production lifecycle estimated at 15 years. Obsolescence issues could be examined, or addressed, about every 15 years of a 30-year service life. In 1995, the component manufacturing lifecycle was estimated to be about 7 1/2 years. Boeing estimates that in 2005, obsolescence will have to be addressed every 5 years and this is working under the estimate that the production life span of a component is only 18 months. Thus, a new generation of electronic components will be required every 5 years to support commercial airplanes throughout their production and service lifecycle. If this issue is not addressed up front, Boeing estimates that frequent design changes, equipment re-certification efforts, and costly shortages of replacement components will occur.

3 Condra, Lloyd, Minimizing the Effects of Electronic Component Obsolescence, June 2000, p. 5.

4 Ibid, p. 6.

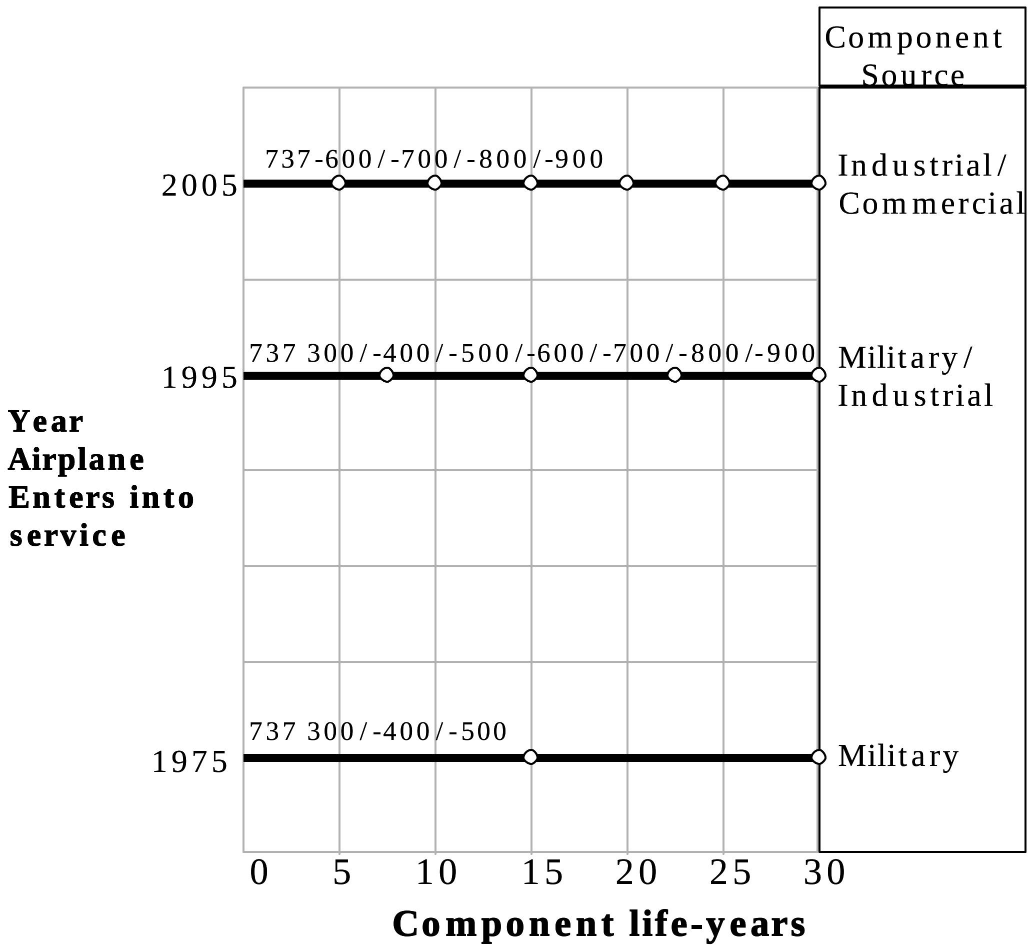


Figure 7. Generations of Electronic Components Required to Support the Boeing 737 Throughout its Production and Service Life.

Boeing established a company-wide Obsolescence Management Board to address the issues related to component obsolescence. This board is responsible for identifying processes, tools, and structures for common obsolescence management solutions throughout Boeing.

2. Selection and Management of Electronic Components

The second part of Boeing's approach to mitigate obsolescence is the selection and management of their electronic components. In the early 1990's, Boeing identified component obsolescence as a major issue within the company. In 1991, the Boeing commercial airlines group initiated a program that requires the suppliers of electronic equipment and original equipment manufacturers, both inside and outside of Boeing, to document the processes used to select and manage electronic components. Components must comply with an approved plan making the supplier and manufacturer responsible for managing the components used in the delivered equipment. As a result of this management plan, the commercial airline manufacturers and customers are no longer involved in the day-to-day piece-parts selection of components. Allowing the original equipment manufacturer (OEM) to use available commercial and industrial components makes it possible for them to replace limited military grade components, which have suffered heavily from obsolescence. As a result, the original equipment manufacturer can use greater flexibility in the design of their equipment and respond to component obsolescence issues as they occur. In the long run, Boeing projects that allowing the OEM's greater component selection responsibility will reduce costs and turnaround of the electronic equipment.

In 1998, the Boeing Military Aircraft division, capitalizing upon the efforts of the Boeing commercial airlines group and their handling of obsolescence issues, developed a single component management plan to cover the APACHE helicopter, the AV-8B Harrier, the F/A-18 Hornet, the F-15 Eagle, and the T-45 Trainer. This management guide made the original equipment manufacturers responsible for both covering piece-part component selection in design and the resolution of obsolescence issues. The OEM must take the responsibility to select their own internal processes to pick the components used in the assemblies that are designed and manufactured to a particular specification.

Boeing has taken on part of the responsibility to work with the "Avionics Working Group" authorized by the International Electro Technical Commission (IEC) to assist in the development of a component management process for all programs and customers in the airline industry. This working group includes most of the airplane and electronic manufacturers in North America and Europe, as well as both the defense agencies, and the US Federal Aviation Administration (FAA). The Boeing component manufacturing process working group is assisting in the development of international standards to ensure that all components used in the aerospace industry are selected, applied, and placed in service according to documented and constantly controlled processes.

3. Design of an Electronic System and Equipment Component.

The third part of the Boeing process is the design of an electronic system and equipment component. The component electronic piece-part obsolescence issue is forcing the manufacturers of electronic equipment to change the actual design of the equipment. Boeing's management monitors this situation through various activities:

- Review performance requirements
- Conduct design review assessments
- Anticipate components technology trends
- Develop avionics technology road maps
- Plan for system upgrades
- Assure flexibility of design and redesign

Boeing is looking at all of its performance requirements to ensure that unnecessary requirements that were once developed and considered necessary, but under further review may no longer serve the purpose originally intended, are eliminated. Part of the review of performance requirements entails the elimination of the detailed "how to" requirements for the OEMs. This allows the equipment manufacturers to use their best practices and expertise to build the equipment to particular performance specifications.

The second part of the approach is to conduct various design review assessments. A component obsolescence assessment is now included in major design reviews for building electronic equipment. These reviews include various estimates and the expected availability of the electronic components. These provisions ensure that the equipment will be available and supported throughout the production lifecycle. Also, part of the Boeing plan is to anticipate component technology trends. The timing of specific component changes cannot be predicted accurately, so the OEMs must anticipate these trends according to "Moore's Law." Moore's Law states that a semi-conducted device would double in complexity about every 18 months[5] and that new designs should provide layout flexibility to accommodate these changes.

Boeing is also working with the aerospace industry to develop technology trends and the market forces associated with them. This is the third part of the plan. Roadmaps,

5 Ibid, p. 8.

the fourth part of Boeing's plan, include information about the technology trends and the effects obsolescence has on these trends. Boeing then uses the roadmap information to coordinate future designs and upgrades to the equipment. The turnover in technology is such that periodic equipment upgrades are necessary to maintain the service life of the system. As the piece-part components become obsolete, it is necessary to redesign the equipment or to make some life-of-type buy and then store the components to maintain production for a certain period of time. Both the redesign and the last-time-buy of components require a tradeoff analysis to determine the necessary solution and the opportune time to implement the resolution. Figure 8 graphically shows a cost tradeoff methodology for redesign versus a lifetime buy.

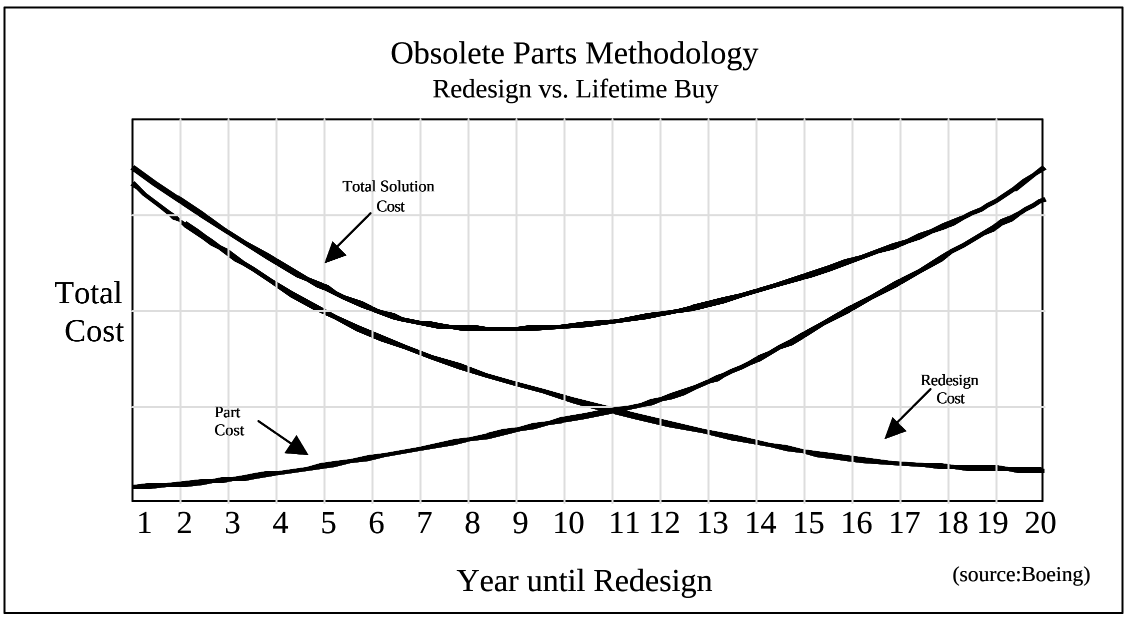


Figure 8. Redesign Cost Tradeoff Analysis.

Planning for system technology upgrades, the fifth part of Boeing's plan, is necessary in order to remain current with the turnover in and evolution of technology. It is necessary to plan a redesign and then buy a sufficient quantity of components to support the equipment until the redesign is available. Using the same chart featured in Figure 8, the optimum year for redesign can be determined based upon various characteristics. Characteristics such as the cost of the inventory, the design, the re-certification, and the potential future obsolescence of the new design are considered. The target cost of the redesign could shift based upon the various factors noted in the chart.

Part six is to design, and redesign, to ensure flexibility so that design concepts can be used to ease the effect of design changes caused by component obsolescence. Concepts include the use of open systems architecture when it comes to interfacing with the equipment subassembly. Costs associated with redesign are reduced when these interfaces are defined. Component obsolescence also makes it possible to bring new technology into a system already needing to be redesigned. Design and redesign can also take into account the use of defining complex elements with Very High Speed Integrated Circuit (VHSIC) Hardware Description Language or VHDL for short. This design technique will be discussed later in the tools section. Adopting industry standard interface formats also helps in future changes that can be introduced into the initial circuit design.

4. Operation, Maintenance and Support of Electronics

Operation, Maintenance, and Support of Electronics is the fourth part of the Boeing management plan. Component obsolescence complicates the maintenance and support of aerospace equipment. The number of different component package styles has increased and many specialized assembly equipment materials and processes may not be realistic for all maintenance shops. The design of electronic equipment and the use of standard electronic industry specifications do not necessarily take into account airplane maintenance practices in potentially hot and cold environments. Recommended procedures may be called for to bring the localized environment within specific temperature ranges for maintenance of this type of electronic equipment. There may be occasions where it may be necessary to cool airplanes that are in an extremely hot temperature environment so that the electronic equipment can work within the manufacturer of the individual component’s specified temperature range.

5. Qualification and Certification of Electronic Equipment

The fifth part of the Boeing plan is the Qualification and Certification of Electronic Equipment. Unlike military practices, regulatory agencies do not approve specific electronic components in the commercial avionics industry. The approval occurs with the demonstrated performance at the equipment level. When new equipment is certified, the parts used in the design are included in the certification. When an obsolete component is replaced in an equipment modification, it becomes necessary to re-certify the equipment by approving the part based upon testing or analysis. The equipment that the component goes into has to maintain its original qualification based upon its function. Federal Aviation Administration (FAA) regulations require replacement and modification of piece-part components be obtained from manufacturers with parts manufacturer approval. In response, the aerospace industry is proposing the following definition of an electronic or electrical standard part:

> A part that is produced and conforms with a specification published and maintained by a consensus standards organization, a Government agency, or a holder of the design approver and used within manufacturers operating characteristics environmental ranges, or selected, applied, and managed by the design approver holder in conformance to an industry consensus component management document.[6]

The last clause in the definition can be satisfied by the Industry Consensus Component Management Document being prepared by the IEC working group, of which Boeing is presently a member.

Sextant Avionique has also developed a management plan in response to the ever-increasing obsolescence announcements. Sextant created a working group in 1996 to address component obsolescence. The working group has divided its efforts into three major initiatives, prevention, detection, and curative.

The working group's initiative on prevention is to consider potential obsolescence in the original design of the assembly or circuit card. The design engineers regularly receive an update of a list of authorized piece parts. Sextant also limits all designs of circuits to only two processor families when a processor is required. Sensitive devices are identified and special care is provided for software-related components. Design rules are in place to use modularity to better separate operational and hardware functions, and prepare for potential upgrade opportunities.[7]

A process was implemented to detect obsolete components. Sextant created a permanent dedicated team within purchasing to conduct market surveys with a special

6 Ibid, p. 9.

7 Airline Maintenance Conference, "Parts Obsolescence" Sextant Briefing, May 12, 1997.

focus on sensitive components, and a regular update of all the authorized piece-part components used. Procedures were set up to identify affected components and disseminate information to the users along with a decision process for mitigation resolutions.

The curative actions that are in place consist of the dual-sourcing of existing replacement components by qualifying alternate sources and using alternate manufacturers. Inventory management is another action that consists of comparing the in-stock inventory to consumption and making a "last-time-buy" to cover potential shortfalls. Redesign is also considered at the piece-part sub-assembly of some higher assembly units.

The American Institute of Aeronautics and Astronautics (AIAA) developed an approach to deal with critical parts in its "Recommended Practices for Parts Management." While in the initial design or redesign process, the AIAA calls for technology assessments and risk mitigation strategies to mitigate program impacts due to obsolescence. Along with technology assessments, the AIAA calls for the use of standard parts since the use of non-standard parts reduces the number of potential suppliers of the components.[8]

C. TOOLS CURRENTLY AVAILABLE TO MITIGATE OBSOLESCENCE

There are many obsolescence mitigation tools available to the pre-production ACAT-ID Program Manager. Many of the tools available are created to mitigate obsolescence by aiding the design engineers in their design while others serve as a forecasting tool to assist the Program Office in addressing future obsolescence issues. Both the commercial and military industries use many of these tools in their day-to-day operations.

One of the companies analyzed for this thesis was i2 Technologies. TACTech/Research Analysis Corporation (TACTRAC) is the product within i2 Technologies that assists in the mitigation of obsolescence. TACTRAC is a client server software system with desktop application for component engineering.[9]

8 AIAA Recommended Practice Parts Management R-100-1996, p. 14.

9 Doubleday, Keith, Solutions for Managing Obsolescence, Presentation at DoD DMSMS Teaming Group Meeting, January 30-31, 2002.

In the design process, TACTRAC provides a component life cycle projection for each microcircuit, diode, and transistor. The life cycle codes vary from 1 to 5, based upon the technology of the component, the number of manufacturers producing the component, the volume of sales, and the number of customers purchasing the component.

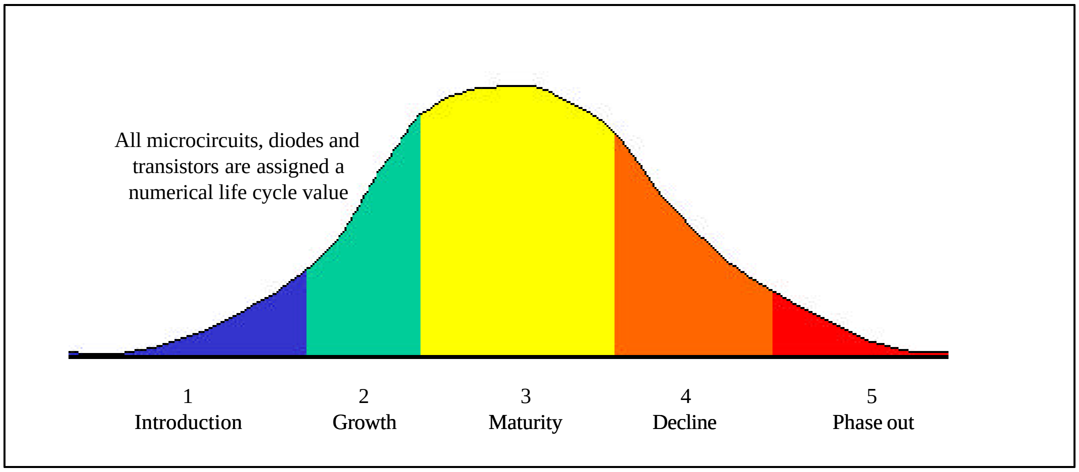


Figure 9. Life Cycle Codes.

The life cycle status of the components enables the design engineer to choose components that are early in their projected life cycle and also permits the Program Manager to influence the design to incorporate components early in the design process.

A configuration management subroutine is built into the software for use as a proactive obsolescence tool. This process enables the Program Office to create a hierarchy that helps manage the program and system from a top-down perspective. The TACTRAC health model provides a visual color-coded barometer of the overall health of the system. Components are given a RED-YELLOW-GREEN rating based upon whether the items are procurable, unprocurable, or obsolete. The health algorithm also provides a high-level indication of status and isolates the problem areas.[10] The TACTRAC library is updated daily with manufacturer information on the procurability of components.

The TACTRAC health model can be programmed by the user and can project the life cycle status two years, four years, six years, or eight years into the future. As seen in Figure 10, a bill of materials is projected out for seven years. The Program Manager,

10 Ibid.

with this information, is able to determine what courses of action might be necessary in out-year applications.

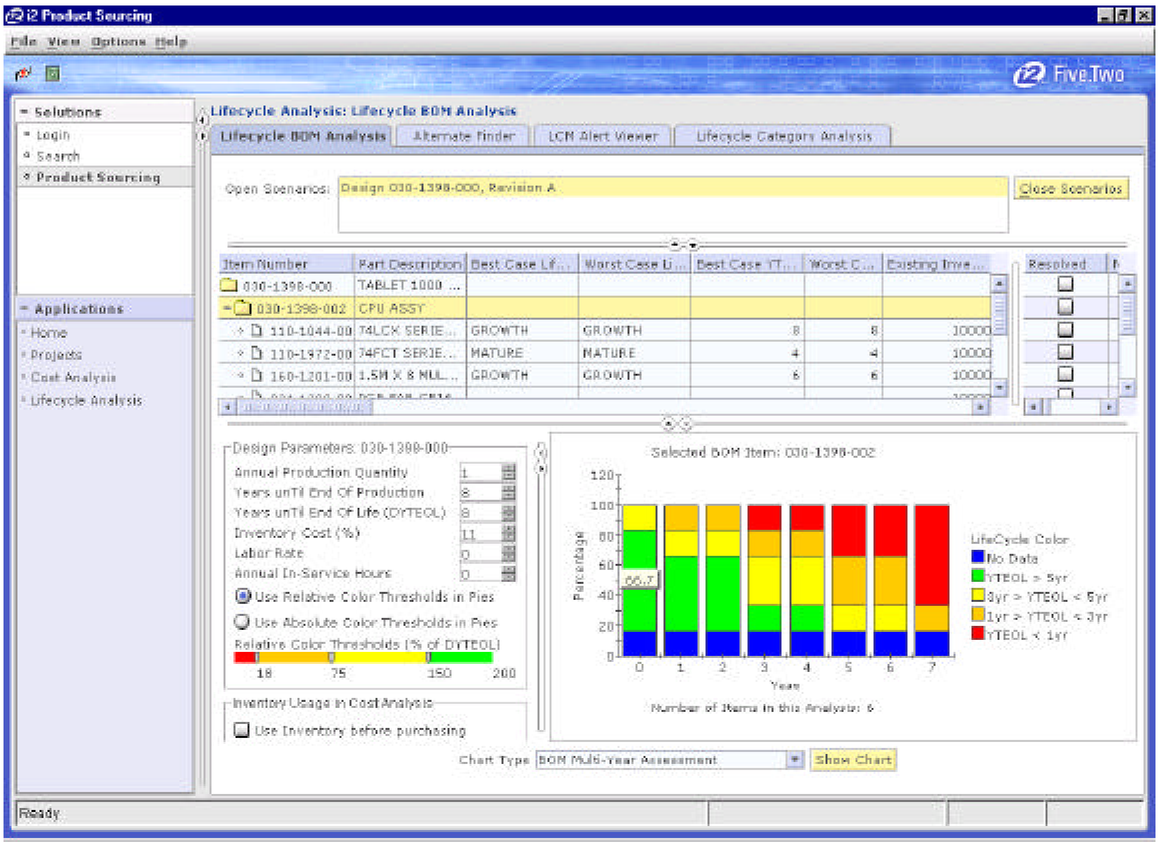


Figure 10. Projection of a Bill of Materials.

Cost information can be correlated with the obsolescence projections from the TACTRAC health model. At the circuit card level and higher, the TACTRAC health model can be projected two years, four years, six years, or eight years into the future. These models show when it is more cost effective to either modernize the circuit card or to work on component-level solutions.

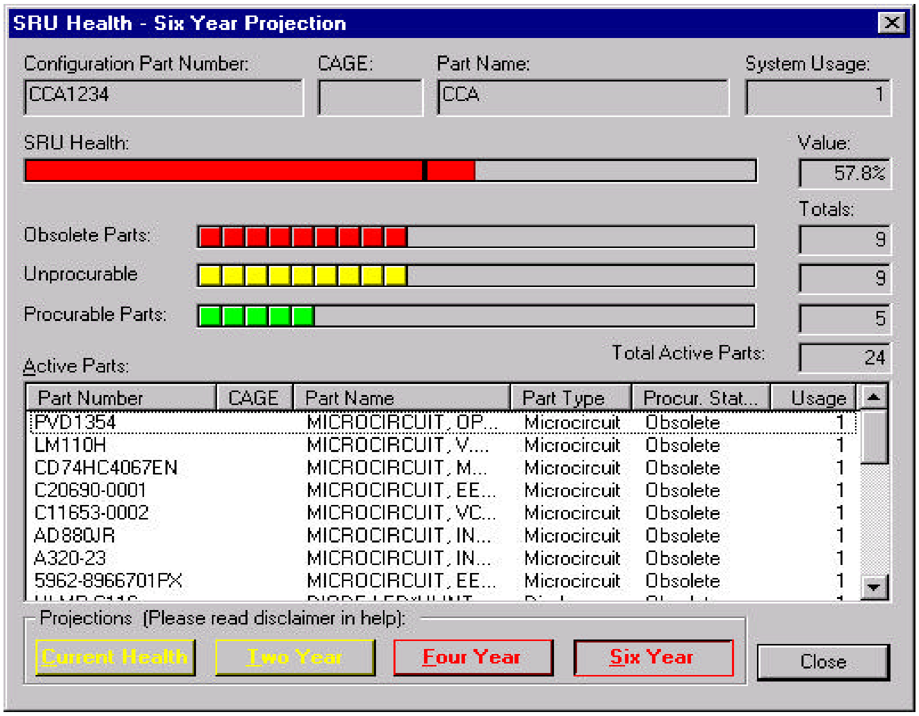
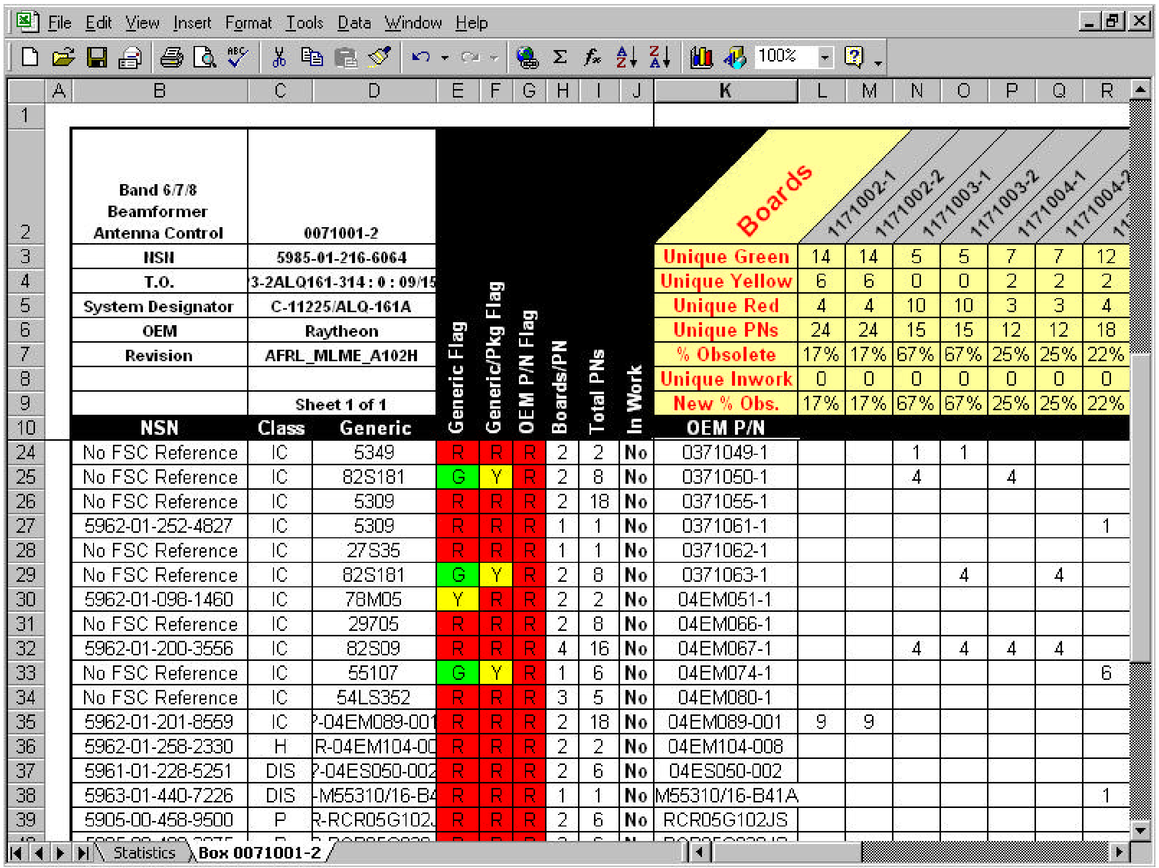


Figure 11. Cost Information Projection at Six Years.

The Program Manager can derive funding strategies to deal with obsolescence issues as they occur without conducting a yearly circuit card analysis.

Manufacturing Technology Incorporated (MTI) has developed an obsolescence management tool called AVCOM. The Avionics Component Obsolescence Management (AVCOM) tool is an obsolescence management device that provides instantaneous obsolescence assessments and status for the Program Manager. This allows the PM to proactively plan and manage electronic component obsolescence issues. The AVCOM tool instantly researches obsolete components and their associated assemblies, locates replacement parts and manufacturers, and can plan and budget for an obsolescence program. The AVCOM tool analyzes the components entered by the Program Office and gives the components a RED-YELLOW-GREEN procurability status. Each component that has been determined to be non-procurable is analyzed against the hundreds of thousands of components within the AVCOM database to identify candidates to be replacement components and the Program Office is notified of the results. As seen in Figure 12, a workbook plots obsolescence against the boards they populate and highlights obsolescence densities.



Band 6/7/8 Beamformer Antenna Control	0071001-2
NSN	5985-01-216-6064
T.O.	3-2ALQ161-314 : 0 : 09/15
System Designator	C-11225/ALQ-161A
OEM	Raytheon
Revision	AFRL_MLME_A102H
	Sheet 1 of 1

Boards	1171002-1	1171002-2	1171003-1	1171003-2	1171004-1	1171004-2	11
Unique Green	14	14	5	5	7	7	12
Unique Yellow	6	6	0	0	2	2	2
Unique Red	4	4	10	10	3	3	4
Unique PNs	24	24	15	15	12	12	18
% Obsolete	17%	17%	67%	67%	25%	25%	22%
Unique Inwork	0	0	0	0	0	0	0
New % Obs.	17%	17%	67%	67%	25%	25%	22%

NSN	Class	Generic	Generic Flag	Generic/Pkg Flag	OEM P/N Flag	Boards/PN	Total PNs	In Work	OEM P/N	1171002-1	1171002-2	1171003-1	1171003-2	1171004-1	1171004-2	11
No FSC Reference	IC	5349	R	R	R	2	2	No	0371049-1			1	1			
No FSC Reference	IC	82S181	G	Y	R	2	8	No	0371050-1			4		4		
No FSC Reference	IC	5309	R	R	R	2	18	No	0371055-1							
5962-01-252-4827	IC	5309	R	R	R	1	1	No	0371061-1							1
No FSC Reference	IC	27S35	R	R	R	1	1	No	0371062-1							
No FSC Reference	IC	82S181	G	Y	R	2	8	No	0371063-1				4		4	
5962-01-098-1460	IC	78M05	Y	R	R	2	2	No	04EM051-1							
No FSC Reference	IC	29705	R	R	R	2	8	No	04EM066-1							
5962-01-200-3556	IC	82S09	R	R	R	4	16	No	04EM067-1			4	4	4	4	
No FSC Reference	IC	55107	G	Y	R	1	6	No	04EM074-1							6
No FSC Reference	IC	54LS352	R	R	R	3	5	No	04EM080-1							
5962-01-201-8559	IC	?-04EM089-001	R	R	R	2	18	No	04EM089-001	9	9					
5962-01-258-2330	H	R-04EM104-00	R	R	R	2	2	No	04EM104-008							
5961-01-228-5251	DIS	?-04ES050-002	R	R	R	2	6	No	04ES050-002							
5963-01-440-7226	DIS	-M55310/16-B4	R	R	R	1	1	No	M55310/16-B41A							1
5905-00-458-9500	P	R-RCR05G102J	R	R	R	2	6	No	RCR05G102JS							

Figure 12. Plot of Obsolescence Across the Boards.

The AVCOM tool can calculate the projected life expectancy of each component and from that projection calculate the out-year health status of the circuit cards. The obsolescence projections have been measured to an accuracy of greater than 90%.[11]

11 Amspecker, Mike, AVCOM and the DMS Management Process, Presentation at DoD DMSMS Teaming Group Meeting, January 30-31, 2002.

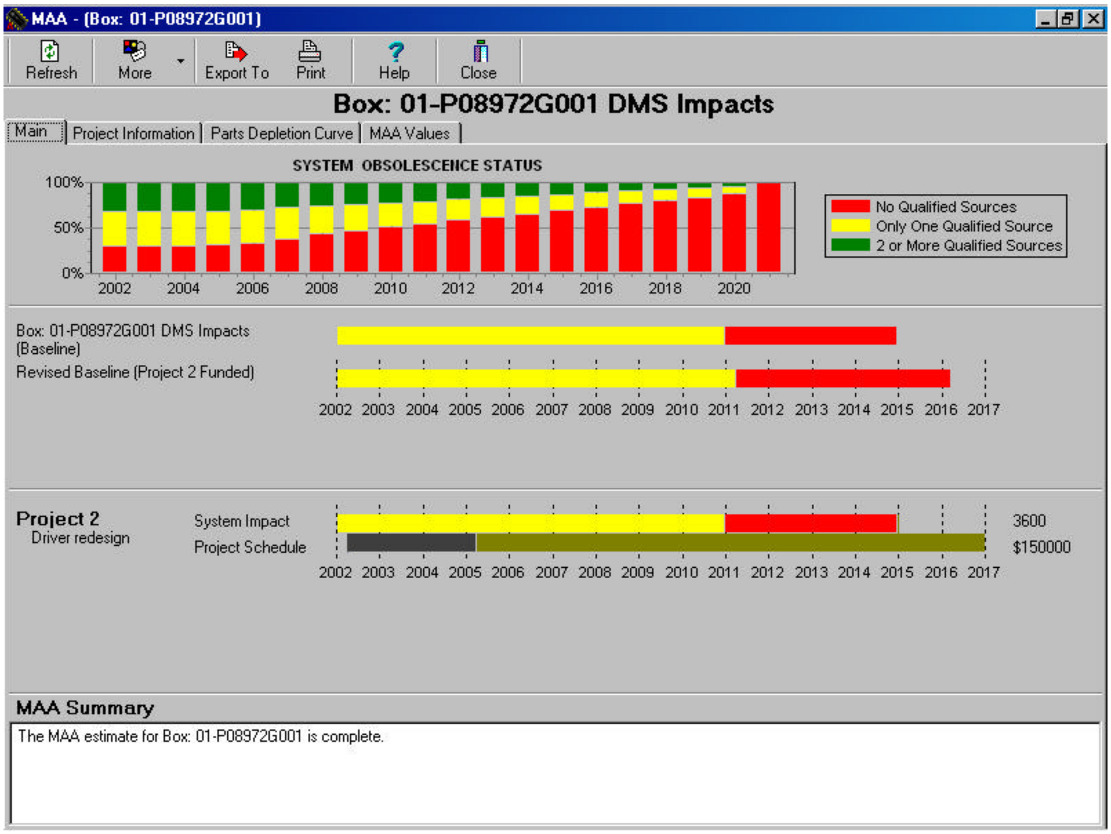


Figure 13. Obsolescence Projections.

Manufacturing Technology Incorporated provides another tool that works similarly to, and in conjunction with, an AVCOM tool called Parts Plus. This tool provides discontinuance notices and can e-mail the issues directly to the PMO obsolescence point of contact as with AVCOM. In addition, it can also provide an analysis on the component generic die. This additional capability allows the Program Office to review an obsolescence issue from the lowest level of component manufacturing and make the purchase of the die optional and have the die repackaged to the specifications of the original part. Parts Plus can also search for aftermarket sources such as suppliers who have purchased the residual component from the manufacturer that discontinued the component product line. The tool can search for commercial, industrial, and military parts and for components equivalent to the original part.

The AMCOM Aviation and Missile Command Obsolescence Group also has a tool available to assist the Program Manager in out-year projections for components. In addition to the capabilities mentioned earlier in this chapter, the AMCOM Aviation and

Missile Command Obsolescence Group uses a formula to project out-year forecasting. The formula is:

<table>
<tr><td>Semiconductor life-span projections</td><td>Multiplied by</td><td>Obsolescence resolution budget requirement by year</td></tr>
<tr><td>
<table>
<tr><th>Reference P/N</th><th>Generic Flag</th><th>Generic Avail</th></tr>
<tr><td>M38510/08003BCA</td><td>2 or More</td><td>1-2 years</td></tr>
<tr><td>M38510/13002BEX</td><td>Sole Source</td><td>1-2 years</td></tr>
<tr><td>M38510/20803BJX</td><td>Sole Source</td><td>1-2 years</td></tr>
<tr><td>5962-8552301QX</td><td>Sole Source</td><td>3-4 years</td></tr>
<tr><td>5962-8680301LX</td><td>Sole Source</td><td>3-4 years</td></tr>
<tr><td>5962-87630022X</td><td>Sole Source</td><td>3-4 years</td></tr>
<tr><td>2N2222</td><td>2 or More</td><td>5-7 years</td></tr>
<tr><td>4344/BCBJC</td><td>Sole Source</td><td>5-7 years</td></tr>
<tr><td>5962-8757001QX</td><td>Obsolete</td><td>Obsolete</td></tr>
</table>
</td><td>Problem resolution cost estimates and statistical probability of occurrence (i.e.) Part Substitution, Bridge buy, Redesign, etc</td><td>
<table>
<tr><th>Year</th><th>Projected Cost</th></tr>
<tr><td>2001</td><td>$ 988,009.75</td></tr>
<tr><td>2004</td><td>$ 673,149.50</td></tr>
<tr><td>2007</td><td>$ 1,064,010.50</td></tr>
<tr><td>2010</td><td>$ 1,530,872.25</td></tr>
<tr><td>2013</td><td>$ 466,861.00</td></tr>
<tr><td>2016</td><td>$ 694,864.00</td></tr>
<tr><td>2019</td><td>$ 195,430.50</td></tr>
<tr><td>2025</td><td>$ 2,746,884.25</td></tr>
</table>
</td></tr>
</table>

Figure 14. Formula to Calculate Out-Year Cost Projections.

Another tool is provided by Information Handling Services (IHS) and is called CAPS Expert. This subscription tool is a resource for more than 15 million electronic components. CAPS Expert is a decision support tool for selecting components and suppliers from product development throughout the entire product life cycle. By using CAPS Expert, the user can view datasheets, revision histories, application notes, and end-of-life notices and quickly find replacement parts, upgrades, and downgrades. Through a parametric search, a component can be chosen by inputting various parameters such as temperature, package type, rise-time, manufacturer, and other parameters.[12] The view of the manufacturers' datasheets allows the design engineers to have a reference and a detailed description of each of the components selected.

In addition to CAPS Expert, IHS has a tool called Catalog-Xpress that allows the Program Office to be able to quickly locate product and component information by keywords, brand names, part or model numbers, standards, National Stock Numbers (NSNs), Mil Specs, and manufacturer names. Catalog-Xpress has information on over 10,000 GSA contractors, including complete catalogs from more than half of these contractors, U.S. Federal Supply Schedules, and GSA-related publications.[13]

12 Information Handling Services Website: http://www.ihs.com/product_demo/capsexpert/index.html, July 2002.

13 Information Handling Services Website: http://www.ihs.com/catalogxpress/index.html, July 2002.

The last tool evaluated from IHS was HAYSTACK, which has information on over 100 million items in the U.S. Federal Supply Catalog. This tool, using a component part number, can determine its manufacturer and research past Government award histories.

The Government-Industry Data Exchange Program (GIDEP) obsolescence Program is a Government-owned and operated tool and is free to Government Program Offices. GIDEP is designated as the Department of Defense centralized database for managing and disseminating obsolescence information. The database contains data not only for parts manufactured in accordance with military or Government specifications, but also for commercial parts. GIDEP is a cooperative activity between Government and industry participants seeking to reduce or eliminate the expenditure of resources by sharing technical information.

Since GIDEP's inception, participants have reported over $1 Billion in the prevention of unplanned expenditures.[14] In the evolution of components to be used in a design, the Program Manager can submit the bill of materials to GIDEP as a batch and in return receive results that assist in evaluating components for either obsolescence issues or safety issues related to a particular component.

A design tool used in the development of a circuit and system design is VHDL. VHDL is a standard (VHDL-1076) developed by IEEE (Institute of Electrical and Electronics Engineers). VHDL can be used for documentation, verification, and synthesis of large digital designs. In addition to being used for each of these purposes, VHDL can also be used to take three different approaches to describing hardware. These three different approaches are the structural, data flow, and behavioral methods of hardware description.[15] In VHDL, the schematic diagram of the circuit or system is decomposed into blocks. These blocks are then connected together to form a complete design. Every portion of a VHDL design is considered a block. A VHDL design may be completely described in a single block, or it may be decomposed into several blocks. The value of the VHDL design is that once the functionality is derived into a software format,

14 GIDEP Webpage: http://www.gidep.org/, June 2002.

15 Green Mountain Computing Systems, An Introductory VHDL Tutorial, http://www.gmvhdl.com/VHDL.html

the software code is synthesized into a code that can be programmed into a gate array chip. If the particular chip becomes obsolete, the VHDL code can be re-synthesized to be programmed into a different chip, whereby all the functionality of the original circuit is maintained.

Another Government tool available to the Program Manager at no cost to the program, is the DMSMS Teaming Group. To address the issue of component obsolescence, the Office of the Undersecretary of Defense for Logistics (OUSD-L) established the DoD DMSMS Teaming Group. The Teaming Group is a formalized group of representatives from DoD programs and industry that work together to share solutions to common component obsolescence problems. The Teaming Group maintains a database of current information on component obsolescence and, whenever possible, explores resolutions that will work for all programs experiencing the obsolescence problem, often reducing the cost.[16] In order to access the database and tool, the Program Office must participate in DoD DMSMS Teaming Group activities. Team members communicate via telephone conference calls every two weeks and attend regular quarterly meetings lasting three to five days. Teaming Group members must also develop a list of obsolete component part numbers and periodically update the Teaming Group database with the resolutions selected for their procuring activity's program and with newly-identified obsolete components.[17]

One of the most powerful tools at the Program Manager's disposal is the use of contract language. During the conceptual phase, the Program Office determines the future supportability strategy. Items considered are readiness, total ownership cost objectives, and types of performance-based logistics. It is during the conceptual phase that many obsolescence mitigation practices, such as VHDL, would be cost effective to implement and should be considered to reduce the future risk of obsolescence. The conceptual phase also provides the opportunity to release a draft request for proposal

16 Martinez, Jerry G., DoD DMSMS Teaming Group How it Works and the Benefits to You; October 1998.

17 Ibid.

(RFP) to obtain feedback on proposed obsolescence contractual language that would be used for subsequent phases.[18]

During the development phase, obsolescence requirements should be included in the RFP. If there is no obsolescence requirement, the contractors may focus on keeping their costs down in order to win the award. The others, believing that specific practices that reduce the risk of obsolescence should not be specified in a contract, prefer to suggest practices as a discriminator during source selections. In conjunction with the award of the development contract, the PM establishes a Part Materials and Processes (PMP) integrated product team. The PMP-IPT should have the mechanism to provide a list of obsolete problem parts to the IPT. For developmental contracts, the IPT should participate in the DoD DMSMS Teaming Group and GIDEP to resolve the problem parts list and reduce the associated resolution costs. If not specified by the contract, contractor participation in the DoD Teaming Group is left to the discretion of the contractor.[19]

D. CURRENT METHODS USED IN ACAT-ID, PRE-PRODUCTION PROGRAMS, TO DETECT AND MITIGATE OBSOLESCENCE ON MISSILE PROGRAMS AT REDSTONE ARSENAL

Multiple PMO's have various forms of obsolescence programs, depending on their particular needs based upon the system life cycle, funding, and obsolescence issues. One of the activities at Redstone Arsenal, the Electronics Analysis and Prototyping Group, is available to team with a missile program to assist the Program Manager in mitigating the impact of obsolescence.

The Lower Tier Project Office, which comprises the basic PATRIOT Missile, the PARTIOT Advanced Capability 3 (PAC-3), and the Medium Extended Air Defense System (MEADS), chartered its Production and Configuration Management Division Chief to be in charge of component obsolescence issues within the program. The Charter reads:

> As chairman of the Obsolescence IPT, you are the primary Lower Tier Project Office official providing guidance for all decisions associated with obsolescence. You are responsible to the Lower Tier Project Manager for providing and assuring effectiveness of:

18 Tomczykowski, Walter, DMSMS Acquisition Guidelines - Implementing Parts Obsolescence Management Contractual Requirements; Prepared for Defense MicroElectronics Activity (DMEA), December 2001.

19 Ibid.

- Obsolescence Management and problem resolution through the IPT process.
- Applying resources and expertise to identify, analyze, and resolve technical issues.
- Identifying, analyzing, and selecting Lower Tier System alternate solutions to current O&S Cost related to obsolescence.
- Maintaining visibility to cost-drivers related to obsolescence by reviewing System Readiness drivers, high cost procurements, and high demands/failures of spare and repair parts.
- Independent assessments/economic analyses, validated, and staffed for each cost reduction candidate selected as a cost reduction initiative(s).
- Develop overall solutions ensuring that each proposed alternative solution(s) has an executable program plan to include identification of funding source.

In addition, each of the other divisions has been given a set of tasks to assist the Production and Management Group in the handling of component obsolescence. In 1998, the PATRIOT Project Office created, and funded, the PATRIOT Joint Obsolescence Partnership IPT. The IPT continued after the Project Office became Lower Tier as a result of a reorganization. This IPT uses the expertise of the Lower Tier Project Office, the AMCOM Electronics Analysis and Prototyping Group, the AMCOM Integrated Material Management Center (IMMC), various Scientific and Engineering Technical Assistance (SETA) contractors, Raytheon, and Lockheed Martin. The Lower Tier Joint Obsolescence Partnership IPT, to the best of their ability, identifies component obsolescence issues, and, within the partnership, recommends resolutions to these issues. For effective management of obsolescence issues, all members communicate in order to maximize the expertise of the partnership teaming effort. The members of the team ensure that the team leader is apprised of all ongoing obsolescence efforts.

Parts obsolescence data, gathered by all associated Lower Tier Project Office contractors and Government activities, is stored in a central obsolescence database located at the Raytheon facility in Tewkesbury Massachusetts. Each Government activity and contractor facility may have their own internal obsolescence program process, but the results are stored in the central obsolescence database. The Lower Tier Project Office uses an obsolescence rating system for management and program-level assessments. A

RED/YELLOW/ORANGE/GREEN variation of the Electronics Analysis and Prototyping Group system is used as follows for piece-part components:

CODES:	**LEGEND:**
G1	No end-of-life issue
Y1	End-of-life issue
Y2	Qualified Source List (QSL) supplier will not supply to Source Control Drawing (SCD) Specification
Y3	Available for sole QSL and life cycle code = 5.00
O1	QSL source only available from aftermarket supplier
O2	NON-QSL source only, application testing required
O3	Quality level not available from QSL source
O4	Package not available from QSL source
R	No QSL source
R1	Re-qualification Required
R2	Redesign Required

Table 5. Component Obsolescence Codes.

The Lower Tier Project Office Joint Obsolescence Partnership Team uses the same RED/YELLOW/GREEN approach to associate the obsolescence status of a circuit card assembly (CCA). A solution might be more economical at the CCA level, if multiple components are obsolete, rather than if individual component solutions are needed.

RED	CCA has at least one RED component
YELLOW	CCA has at least one YELLOW component and no RED components
GREEN	CCA has all GREEN components

Table 6. Obsolescence Code of CCAs.

The Lower Tier Project Office Obsolescence IPT has developed a process, similar to the Electronics Analysis and Prototyping Group process, to address the obsolescence issue.

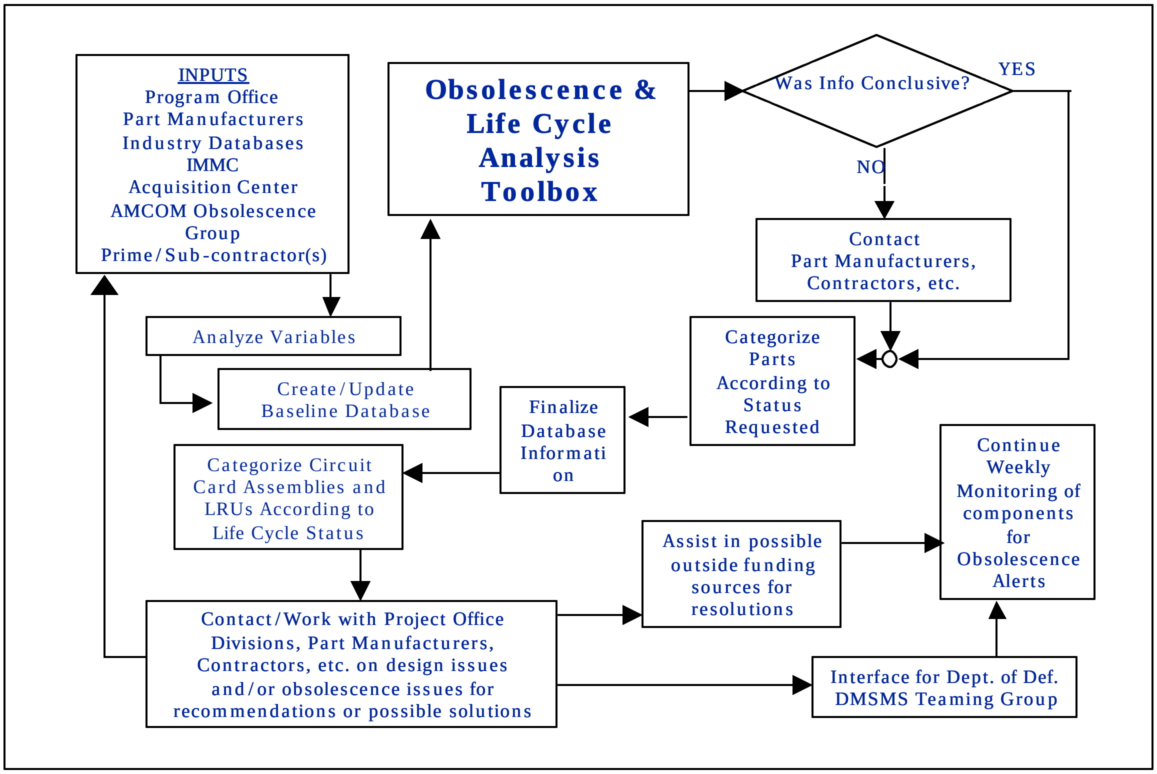


Figure 15. Lower Tier Component Obsolescence Process.

The team coordinates with PATRIOT Foreign Military Sales (FMS) customers within the Lower Tier Project Office concerning which component obsolescence issues affect those systems. The Lower Tier Project Office has developed a FMS obsolescence database, maintained by the Government, that is populated with components that have been identified as having potential or actual obsolescence issue associated with them.

Once components and their associated next higher assembly have been identified for analysis, the team is contacted to determine if any previous action(s) have been taken. The procedure to identify component availability and obsolescence resolutions will generally be as follows, but not limited to:

STEP	ACTION
1	Reference the Qualified Suppliers List (QSL) for a manufacturer's part number or use the specifications associated with the PATRIOT part number to cross to a manufacturer's part number.
2	Create or update baseline database to reflect new information.
3	Run component manufacturer information through obsolescence tools. Various tools include commercial and Government databases that give availability, replacements, and commercial equivalents. Some databases give manufacturer alert notices.
4	If databases were not conclusive then actual contact of manufacturers is necessary.
5	Categorize parts according to obsolescence status.
6	Finalize database information.
7	Categorize circuit card assemblies.
8	Formulate obsolescence recommendations for possible solutions.

Table 7. Procedure to Identify Component Availability and Obsolescence Resolutions.

The Lower Tier Project Office Obsolescence IPT developed a resolution matrix, a variation of the AMCOM matrix, on the possible solutions to obsolescence issues. Each resolution has a cost analysis associated to ensure that the most cost effective solution is chosen.

1	Check Inventory	Evaluate life time needs and if there is sufficient inventory to support demand
2	Pin-for-Pin Replacement	Form, Fit, Function, (FFF) compatible with original, device. Only paper evaluation needed.
3	Life-of-Type (LOT) Buy or Bridge Buy	Buy enough inventory to meet all future requirements or bridge a period of time until another solution can be implemented
4	Alternate Source	Qualify a FFF component source with more then just a paper qualification, e.g. Board or Battery Replaceable Unit (BRU) testing.
5	After-market Package	The Die is Available and Can Be Packaged by an After-market Supplier
6	After-market Manufacture	The Wafer has to be manufactured first, then packaged by an after-market Supplier
7	Substitution with Changes	A part that is not a FFF replacement that needs to be tested and upgraded for the system requirements. (E.g., Plastic Encapsulated Microcircuits (PEM), speed change, failure rate)
8	Emulation	Manufacture or re-engineering of a FFF Replacement
9	CCA or BRU Redesign	Board or System has to be redesigned since no other cost effective resolution exists

Table 8. Resolution Matrix.

Once the Lower Tier Obsolescence IPT has been notified that an obsolescence issue has occurred, the production and configuration management group sends out immediate notice to the FMS customers, each division, and the supply chain to notify them of the obsolescence issue and its potential impact. This group, based upon feedback received, will then determine the possible resolution. The Lower Tier Obsolescence IPT has developed a management plan to assist and inform each customer concerning how the obsolescence issue will be addressed in the Lower Tier Project Office. Independent of the AMCOM Electronics Analysis and Prototyping Group obsolescence effort, the Lower Tier Project Office has joined the DoD Obsolescence Teaming Group (to be discussed later) to assist in obsolescence issues as they occur. The Lower Tier Project Office also funds the AMCOM Obsolescence group for the use of tools and databases to assist them in their obsolescence IPT process. Periodically, the Lower Tier Project Office Obsolescence IPT holds a face-to-face program meeting in which all members, including the FMS customers, can discuss the obsolescence impacts that have occurred and what resolutions may need to be taken. The Production and Management Division publishes a monthly report informing Obsolescence IPT customers of all operations occurring within the preceding month. The FMS database is delivered to the IPT members who update their process and tasks as necessary. Any Obsolescence IPT member can submit various resolution possibilities to the Lower Tier Project Office concerning what actions can possibly be taken. Through a series of different resolution possibilities, the Lower Tier Project Office will establish the most cost effective method for determining a resolution to the component obsolescence issue that has occurred.

As part of the Lower Tier Project Office, the PAC-3 Product Office becomes involved with the Production and Configuration Management Division to assist in handling obsolescence issues as they occur. The PAC-3 Product Office has a relationship with the prime contractor, Lockheed Martin, to screen parts and to assess components. Both Lockheed Martin and the Government can address the obsolescence issues as they occur. The PAC-3 Product Office can then make various resolution determinations based upon the same process used in the Lower Tier Project Office.

The National Missile Defense (NMD) PMO in Huntsville, Alabama, teamed with the AMCOM Electronics Analysis and Prototyping Group to assist with the handling of obsolescence issues as they arise. Boeing, the prime contractor, has the ultimate responsibility for choosing components to be used in the design of the NMD system. Boeing has established an obsolescence IPT within the framework of a Parts Materials and Process IPT. To document the process of choosing components to be used in the NMD system, Boeing developed a Parts Materials and Processes (PMP) management guide, which was contractually approved by the Government. Through the PMP, a Parts Materials and Process IPT was established between Boeing and its subcontractors that covers all aspects of piece-part components, which includes activities such as safety, de-rating, and obsolescence. Boeing has extended the bounds of the IPT to include a Government interface with the NMD Program Office. Through the NMD Program Office, the AMCOM Obsolescence Group serves as the Government subject-matter-expert on electronic piece-part obsolescence.

The Theater High Altitude Air Defense System (THAAD) has a system similar to that employed by NMD. The manufacturing group has developed a working relationship with the AMCOM Electronics Analysis and Prototyping Group. They assist in screening components, at the piece-parts level, to be used in the THAAD system. Lockheed Martin, the prime contractor for THAAD, works under a parts and material process plan similar to the one described for the NMD. Once the components are approved for use in the program, they are periodically screened for potential obsolescence impacts. The AMCOM Electronics Analysis and Prototyping Group serves as their subject-matter-expert for obsolescence.

The Longbow Missile is another missile system that has an established obsolescence program. The Program Office funded the AMCOM Electronics Analysis and Prototyping Group Obsolescence Group to develop a process to interface with Lockheed Martin, the prime contractor, on the Longbow Missile. Periodic meetings between the AMCOM Obsolescence Group and Lockheed Martin manage component obsolescence throughout the lifecycle of the Longbow Missile. As the components are chosen in the design phase, the components are added into a database and then periodically updated for obsolescence impacts.

Another missile program that has a similar program is the JAVELIN Missile. The JAVELIN Missile Program Office funds the AMCOM Obsolescence Group and an IPT has been established between Lockheed Martin, the Program Office, and the AMCOM Obsolescence Group. Lockheed Martin is responsible for conducting a lifecycle analysis on the components before they are submitted as an input to the parts and material process plan. Once chosen, the components are shared with AMCOM in an IPT relationship in order to permit the Government to assist the prime contractor in the screening and management of the obsolete parts.

E. DOD/ARMY MATERIAL COMMAND (AMC)/AMCOM INITIATIVES TO ADDRESS OBSOLESCENCE ISSUES AT THE ARMY ACAT-ID PROGRAM OFFICE LEVEL

In the past few years, the DoD has been very aggressive in developing new initiatives that aid in the management of obsolescence. These initiatives deal with the identification of problem parts, feasibility of alternate parts, testing of commercial replacements, redesign of higher assemblies, and information management systems tools.

The Army has taken the initiative to integrate GIDEP into their obsolescence Information System. This project entails setting up an automated obsolescence notification retrieval and information dissemination system. This system will quickly receive DMSMS part notifications from the GIDEP database, determine which Army systems/equipment may potentially be affected, and then automatically updates the GIDEP system with the projects actually impacted and their reported possible solutions. This information is then shared with the rest of the GIDEP community.

The Defense Logistics Agency sponsors an initiative with which GIDEP is involved. It is called the Shared Data Warehouse. This initiative is a multi-phased project to enhance and improve the sustainability of DoD weapon systems. GIDEP's role within this project is to facilitate a central repository for obsolescence management information. This would automate workflow processes by allowing for systematic searches to be conducted in an automated mode of operation. GIDEP would be the single point of entry, providing a seamless connectivity to various disparate reference data sources.

One of GIDEP's newer services is automated parts matching. Through this service, the Program Office can submit their parts list that will be run against the GIDEP database to determine if there are any non-conforming or obsolescent parts. A report is then returned to the Program Office that shows any obsolescence information relative to their parts list.[20]

The Shared Data Warehouse (SDW) is a Government-owned database application that provides the Program Office connectivity to several existing DMSMS sources. The Program Office subscribes to the service for assistance in mitigating component obsolescence. The SDW is being developed by Industrial Support Programs, Defense Logistics Agency and will enable the DoD to more effectively manage parts obsolescence. The SDW leverages existing information and data resources without replication or relocation. This pool of data will encompass data sources across DoD including databases from the Air Force, Army and Navy. Currently, these databases reside at various DoD activities such as the Defense Supply Center, Columbus; the Defense Logistic Information Service, Battle Creek, Michigan; and GIDEP. The development of a centralized repository for solutions, combined with shared information, can foster common solutions within the DoD and its industry partners.[21]

The SDW data is contained in two databases. The first database is the On-Line Transaction Processing (OLTP) database. The OLTP contains SDW files designed for efficient storage and modification. Data was initially loaded into the OLTP via a mass load process. The second database is the On-Line Analytical Processing (OLAP) database. The OLAP provides a static view of the data to allow users to perform queries and analysis without disruption. To provide nearly constant access to the data, a database design containing dual OLAPs was established. One static OLAP will provide access to query users. OLTP updates will be accumulated and used in a rebuild process to create a refreshed OLAP.[22]

The DMSMS Teaming Group Initiative is the tool described in an earlier section. The Teaming Group is a formalized group of representatives from DoD programs and industry that work together to share solutions to common component obsolescence problems. The goals of this initiative were to expand the Program Office knowledge

20 GIDEP, http://www.gidep.org/, Government Initiatives to Solve DMSMS, May 2002.

21 Ibid.

22 Defense Logistics Agency, http://widow.cols.disa.mil/sdwprd/SDWHOME.HTM, Shared Data Warehouse Users Guide, May 2002.

concerning which programs use specific components so that the potential exists to work together to reopen the production line for an obsolete component. As a group, the team can expand their research capability to identify sources or possible sources of supply and can possibly share the cost of implementing a resolution.[23]

The Defense Microelectronics Agency has developed the Virtual Parts Supply Base (VPSB) with the objective to improve the sustainability of Department of Defense weapon systems through an Integrated Data Environment. The initiative will be accomplished by augmenting the existing supply system with new technology to integrate existing resources. The VPSB is a virtual enterprise that exploits advances in telecommunications and computers. Specifically, it uses the Internet to rapidly and economically provide difficult-to-obtain NSN and non-NSN parts for all categories of DoD weapon systems.

Rapid Retargeting is a design process employing Commercial Off the Shelf (COTS) simulation and modeling tools to capture the functionality of obsolescence-threatened electronic components using hardware descriptive language (HDL). The HDL software model enables the production of state-of-the-art form, fit, and function legacy item replacements. Rapid Retargeting was developed by the Naval Supply Systems Command to enable users of electronic systems to protect their investment by providing a path for technology upgrades. Rapid Retargeting is a design process that uses a collection of sophisticated analysis, simulation, and modeling tools to transform an existing electronic module from the fielded system into a new module with identical form, fit, and function with respect to the target module. The retargeted module, however, is implemented using the most current semiconductor devices available at the time. In addition, the resulting functional representation of the module in software makes subsequent hardware modifications and upgrades much easier.

Hardware retargeting is typically done when existing hardware becomes obsolete or there is some value, such as a new system development, in having software models of hardware functions. Reasons to develop software models include the desire to reuse

23 Martinez, Jerry G., DoD DMSMS Teaming Group How it Works and the Benefits to You; October 1998.

functions across several designs, to change the mechanical form factor of a board, or to allow for planned system upgrades.

The hardware retargeting effort begins by extracting the functionality of the target hardware and capturing it in a hardware descriptive software language. The resulting software models are simulated and compared with the original hardware for verification. Once verified, the models are ported to a new hardware design. Subsequently, parts obsolescence is no longer an issue, since software models can be re-hosted whenever new technology becomes available. Once re-hosting is complete, a packaging engineer then decides which packaging and interconnect technology is required for the desired level of environmental protection.

The Obsolescence Prediction Tool (OPT) was developed for the Naval Supply Systems Command during FY99 as an initiative under the Small Business Innovative Research (SBIR) program. The OPT will use a technology trend forecast engine and customer interface to allow engineers and logisticians to monitor the obsolescence-susceptibility of equipment from the system through the individual component level. Previously accessible to authorized users and located on the GIDEP Web site, OPT access has been suspended while the tool undergoes a significant upgrade. Initial upgrade efforts include the creation of a Technology Trends Database (TTDB), which will ultimately enable users to screen weapons systems/equipment and identify components that are likely to be susceptible to obsolescence.

Modernization Through Spares (MTS), developed by the Army Materiel Command, is a spares acquisition strategy applied throughout the material acquisition life cycle to reduce sustainment costs. MTS is based on technology insertion and the use of commercial products, processes, and practices to extend a system's useful life. The Department of the Army has developed a Strategy for Modernization Through Spares. This strategy assists all Army managers who develop systems or buy spares, such as parts, components, subassemblies, or assemblies, for operational systems. It is based upon leveraging sustainment funds to reduce operating and support (O&S) costs, and the use of an IPT to implement the strategy.

For developmental systems, the IPT uses Cost as an Independent Variable (CAIV) and open systems architectures to enable future performance-based spares acquisition. For operational systems, the IPT used performance-based requirements to insert commercial technologies during the acquisition of spares to capitalize on the cost benefits.

The Plastic Encapsulated Microcircuit (PEM) Initiative is being developed and managed by the Manufacturing Technologies Division, US Army Aviation and Missile Command. The objective of this initiative is to enhance, demonstrate, and implement standardized processes for a coating system for integrated circuits at the wafer level to provide near hermetic capabilities regardless of the packaging approach used. Since the shelf life of many missiles ranges from 10-20 years under a variety of uncontrolled storage conditions, current PEMs have not proven reliable over the long-term. With the use of commercial components not designed for a long-term shelf-life, a process was needed that provides moisture and ionic contamination protection. Initial results under an Air Force S&T program show near hermetic protection capabilities for Dow Corning's ChipSeal™, and a 1-10% increase in part yield due to the greater resistance to scratching provided by the coating. Primary savings to PMs will be the ability to use low-cost PEMs for a much broader range of applications than previously.

The Army DMSMS Information System and web site, developed by U.S. Army Tank-Automotive and Armaments Command (TACOM), is being established for use at all Major Subordinate Commands (MSCs) and HQ AMC. The system has three functions. The first is the identification of the obsolescence issue. The Army DMSMS Information System automatically downloads GIDEP alert notices into the Information System and the database screens for Army impacts. The second part is notification. The Information System automatically broadcasts the Army alerts to affected programs for validation and resolution. The third part is the flagging of the validation and resolution along with capturing the obsolescence cost metric data and transmitting resolution and cost metric data to GIDEP.[24]

24 Garcia-Baco, Luis, DMSMS INFO Overview; DMSMS Conference, August 21, 2000.

The Air Force Research Laboratory, Manufacturing Technology Division, at Wright Patterson Air Force Base, sponsors the Air Force Parts Obsolescence Initiative, the BAA-98-14-MLKT initiative. The objective of the $21 million dollar Government investment and $11 million dollar industry investment is to develop new process applications, tools, and pilot programs to help the Government better manage electronic component obsolescence.

One of the Air Force initiatives is the Application of Commercially Manufactured Electronics (ACME). The objective of ACME is to address key technology-driven issues required to increase the cost-effective use of commercially-manufactured electronics, as military parts become obsolete due, in part, to being discontinued. The Air Force initiative also addresses Obsolescence Management Pilot Programs. The objective of the pilot programs is to address improving corporate-level policies and procedures and the cost effectiveness of parts obsolescence management tools.[25]

The Defense Microelectronics Activity (DMEA) took on the initiative to document the cost of resolving obsolescence resolutions. DMEA is the DoD Executive Agent for microelectronic obsolescence, and has developed cost factors for various DMSMS resolutions so that DoD programs can uniformly report and predict the costs associated with obsolescence resolutions. ARINC, contracted by DMEA to perform the analysis, identified the resolutions most commonly used by the DoD and developed nonrecurring engineering cost factors for each. For each resolution, three cost factors (low, average, and high) were categorized for nonrecurring Engineering Costs associated with the resolution of an obsolescence problem.

Resolution	Low	Average	High
Existing Stock	$ 0	$ 0	$ 0
Reclamation	629	1,884	3,249
Alternate	2,750	6,384	16,500
Substitute	5,000	18,111	50,276
Aftermarket	15,390	47,360	114,882
Emulation	17,000	68,012	150,000
Redesign- Minor	22,400	111,034	250,000
Redesign- Major	200,000	410,152	770,000

Table 9. Nonrecurring Engineering Resolution Cost Factors.

25 GIDEP, http://www.gidep.org/ Government Initiatives to Solve DMSMS, May 2002.

ARINC established the following ground rules and assumptions and coordinated them with DMEA at a technical interchange meeting. The costs are in constant fiscal year 1999 dollars. The NRE cost factors do not include procurement and administrative labor hours, nor do the NRE cost factors include costs associated with developing new microcircuits using state-of-the-art technologies.

The Missile Defense Agency (MDA) is attempting to team with the AMCOM Electronics Analysis and Prototyping Group on a set of obsolescence proposals to provide a common obsolescence management process across all MDA systems. Since each program manages obsolescence uniquely, a Single Process Initiative (SPI) for obsolescence management has been proposed. The SPI program would incorporate hardware surveillance, component analysis, component alert monitoring, and resolution tracking. The SPI would establish an obsolescence working group to review analysis and provide consensus for resolution implementation. The IPT would project out-year modernization and upgrade paths along with calculating out-year obsolescence resolution costs to establish a budget line item.

Another part of the initiative is the obsolescence evaluation of COTS hardware equipment. AMCOM would design a predictive tool to identify specific mitigation strategies and techniques for COTS equipment and assign costs to each mitigation strategy and technique.

The last section of the MDA-AMCOM initiative is a Critical Microelectronics Technology Roadmap. The AMCOM Electronics Analysis and Prototyping Group will identify critical microelectronic applications that will drive system production and sustainment decisions, determine the technology alternatives that can satisfy critical microelectronic needs, select the appropriate technology alternatives, and generate and implement a plan to develop and deploy appropriate cost-effective technology alternatives.

F. CHAPTER SUMMARY

In this chapter various tools, processes and plans applicable to the ACAT-ID Missile Program Manager were researched. The Program Manager has many different avenues that can be followed in the development of an obsolescence plan that can be tailored to his particular program. The commercial industry was also analyzed for the measures taken to mitigate the cost and schedule impacts caused by microcircuit obsolescence. Plans, process, and initiatives from the various armed Services, plus different obsolescence mitigation plans and processes used at the Army Aviation and Missile Command that were constructed specifically for missile programs were reviewed and documented.

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IV. ANALYSIS OF RESULTS WITH MANAGERIAL, TECHNICAL, AND FUNDING RECOMMENDATIONS ON RESTRUCTURING THE DMSMS/OBSOLESCENCE PROGRAM FOR ACAT-ID PROGRAM MANAGERS LOCATED AT AMCOM

A. ANALYSIS OF COMMERCIAL INDUSTRY DMSMS/OBSOLESCENCE ACTIVITIES AND HOW THEY CAN BE LEVERAGED TO APPLY TO MILITARY PROGRAMS

The commercial airline industry obsolescence programs were analyzed because the DoD ACAT-ID Program Manager faces the same types of obsolescence issues as the Program Manager for an airline company. Since Boeing is an airplane manufacturer, special emphasis was placed on the activities that Boeing takes as significant similarity exists with the pre-production DoD ACAT-ID Program Manager. Many of the same techniques that Boeing has used can be leveraged to assist the DoD ACAT-ID Program Manager. The Boeing document, "Guidance for Part Obsolescence Management Plans," is the basis for the obsolescence actions against which the DoD can leverage.

During the design phase, managing the risks of obsolescence is the responsibility of both the program office and the prime contractor's design activity. Many programs or projects may make individual IPTs responsible for performing the tasks outlined in this document rather than creating a separate program-level obsolescence IPT. Programs with multiple IPTs are encouraged to use common obsolescence management plans and processes in order to reduce cost and are also encouraged to maximize data and information sharing.

Based on the Boeing example, the creation of an obsolescence IPT in the design phase is practical. Boeing created a model to make the airline industry responsible for creating the IPT with the subcontractors, while a DoD Program Manager would create an obsolescence IPT with the Prime Contractor and its subcontractors. Boeing also is a member of the airlines obsolescence-working group; the DoD Program Manager has similar working groups to assist in managing obsolescence. The Boeing commercial airlines group initiated a program that required the suppliers of electronic equipment and original equipment manufacturers to document the processes used to select and manage electronic components. The DoD Program Manager can leverage the same type of program by influencing the Prime Contractor to create the same kind of supplier relationships. The result will hopefully result in greater flexibility in both the design of the equipment and responding to component obsolescence issues as they occur.

Boeing estimated that the technology would need to be refreshed every 5-7 years. To mitigate risks in the design phase, parts should be selected based on the low risk of becoming obsolete. Both equipment and parts technology roadmaps should be developed for projecting obsolescence situations. The Boeing Commercial Avionics Systems (CAS) group at Puget Sound developed a rating algorithm to assess obsolescence risk for all electrical and electronic components used on Boeing-made electronics in commercial aircraft.[26] Tools and databases exist that process and interpret these ratings. The DoD Program Manager has similar tools available to the Program Office for the same type of component analysis.

The customers in the airline industry also have a voice in the design since they will ultimately have the program turned over to them once the program is fielded or an airplane is procured. The American Institute of Aeronautics and Astronautics (AIAA) calls for technology assessments and risk mitigation strategies to alleviate program impacts due to obsolescence. Along with technology assessments, the AIAA calls for the use of standard parts since the use of non-standard parts reduces the number of potential suppliers for the components.[27] The same type of design techniques can be leveraged into the DoD Program. By bringing the logistics community into the design process early-on, possible obsolescence issues can be avoided in the future.

B. RESTRUCTURING AND FUNDING FOR THE AMCOM RESEARCH DEVELOPMENT AND ENGINEERING CENTER (AMRDEC) TO SUPPORT THE AMCOM ACAT-ID PROGRAM MANAGER

Whether a program is in the development or sustainment phase, the Missile Program Office must fund the AMCOM Electronics Analysis and Prototyping Group for support. At present, the AMCOM Electronics Analysis and Prototyping Group is funded solely by Program Managers on a cost-reimbursable basis and the support delivered to the Program Office is based upon the amount funds received. An ACAT-ID Program

26 Tanemura, Steve, Guidance for Part Obsolescence Management Plans, Boeing Document D950-10375-1, November 29, 1999.

27 AIAA Recommended Practice Parts Management R-100-1996, p. 14.

Manager has many items to fund in the development phases of the program. The obsolescence situation is an issue that is common to every major missile program and should be treated as such.

The Defense Microelectronics Activity (DMEA) conducted a survey of attendees at the DMSMS '99 Conference in Monterey, CA., which dealt with the obsolescence support given to a Program Office. Many of the respondents mentioned obsolescence funding from the Department of Defense as a way to mitigate some of the obsolescence issues.

The Department of the Defense needs to take a more active role in the mitigation of obsolescence. The DoD has many programs that educate the Program Offices in various techniques and processes that can mitigate the impacts of obsolescence, but provides no direct assistance to the Program Manager. The group is involved in many of the programs that the DoD offers and serves as a knowledge base for the missile programs at Redstone Arsenal. In this area of "Lean Manufacturing," a single process initiative should be established and funded by the DoD to assist the group in their support of the Program Managers.

The MDA obsolescence initiative is such a program and can be of great benefit to all MDA missile programs. Through the subject matter experts in the AMCOM Electronics Analysis and Prototyping Group, a knowledgebase is established with various tools and processes at its disposal.

At the present time, each Program Manager manages obsolescence uniquely, but there is a necessity for common obsolescence tools and processes among ACAT-ID missile program offices. With the present system, there is a resultant lack of cross-communication that precludes PMs from fully realizing the benefits of lessons learned and leveraging opportunities for shared solutions. This results in duplicated effort, increased costs, and a waste of resources.[28] One of the 1999 Obsolescence survey questions poised by DMEA addresses a standard set of process used. "DMS problems would be more manageable if a standard set of acquisition guidelines that address DMS

28 MDA Obsolescence Proposals Briefing May 2002.

requirements were established and followed by the community."[29] In the survey, 55 of the 69 respondents, clearly 80%, felt this was a valid proposal.

If the AMCOM Electronics Analysis and Prototyping Group is to truly serve as the knowledge base for the Program Office, then the Department of Defense needs to fund this office to provide the tools it needs to perform its function. These obsolescence tools include the ability to instantaneously assess the obsolescence status of a microelectronic component. From the component, the tools must be able to evaluate the obsolescence status of the circuit card, and in turn, the entire system can be evaluated for obsolescence impacts.

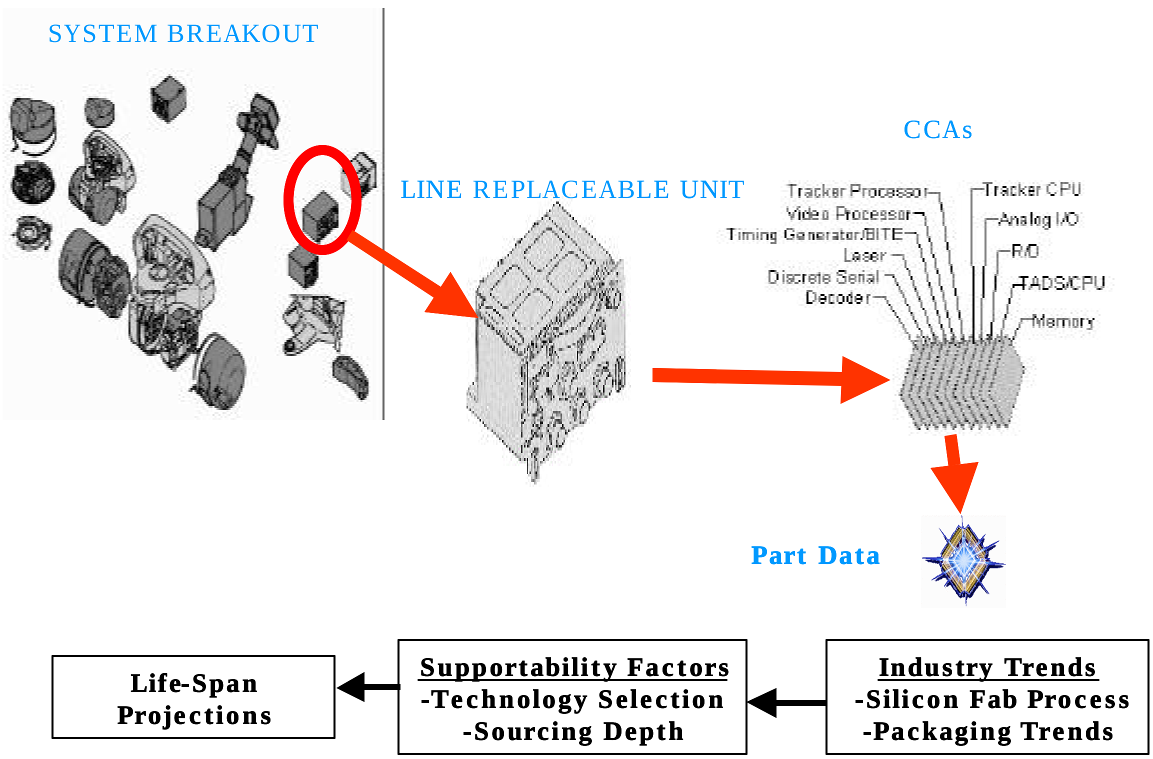

Figure 16. System Decomposition into Piece Part Components.

The process of decomposing the system into smaller and smaller components in order to facilitate analysis is common to all systems. The common practice of then using various algorithms to determine out-year projections can be accomplished using many of the tools discussed earlier.

29 Defense Microelectronics Activity; DMSMS Survey Results, December 1, 1999.

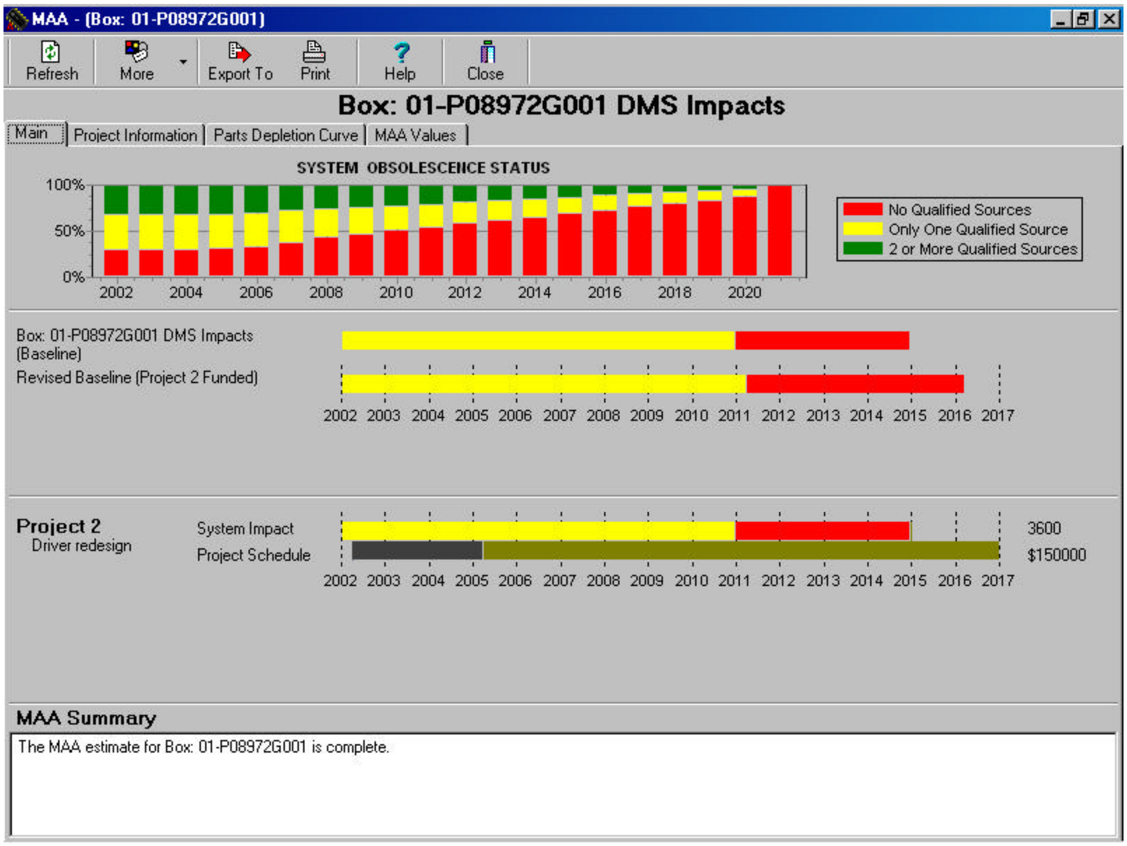

Figure 17. Out-Year Projection of Obsolete Components.

The out-year projections can assist the Program Manager in future-year cost projections needed to mitigate obsolescence.

Year	Projected Cost
2001	$ 988,009.75
2004	$ 673,149.50
2007	$ 1,064,010.50
2010	$ 1,530,872.25
2013	$ 466,861.00
2016	$ 694,864.00
2019	$ 195,430.50
2025	$ 2,746,884.25

Figure 18. Out-Year Cost Projections to Resolve Microcircuit Obsolescence.

The funding of personnel assigned to the AMCOM Electronics Analysis and Prototyping Group should also be restructured in order to provide better service to the Program Manager. The personnel assigned to the group in a supervisory or administrative role do not necessarily serve the Program Management Office (PMO) in a direct manner. These individuals serve to ensure that the direct line engineers are capable of performing their mission. It is the supervisor's job to ensure that the engineers receive training, guidance, and interface with various levels of the command structure, but do not interface directly with the PMO unless problems or funding issues arise. The DoD, AMC, or AMCOM should directly resource with mission funds the supervisory and administrative personnel that support the AMCOM Electronics Analysis and Prototyping Group.

The funding of the AMCOM Electronics Analysis and Prototyping Group supervisory and administrative personnel mission allows the PM to fund at a level that best suits the needs of the program.

C. POLICIES AND PROGRAMS THAT DOD, DEPARTMENT OF THE ARMY, AND AMCOM CAN IMPLEMENT TO ASSIST THE PROGRAM MANAGER IN MITIGATING IMPACTS DUE TO OBSOLESCENCE

One of the programs that the DoD has sanctioned is the DoD Working Group. This group differs from the DoD Teaming Group in that the mission of the Working Group is to recommend management techniques, tools, and policies to reduce life-cycle costs of DoD weapon systems. DMEA has been designated by the Deputy Under Secretary of Defense for Logistics to act as chair of the DoD DMSMS Working Group. The Working Group addresses DMSMS problems from a full DoD perspective, with a small number of core members from the Army, Navy, Air Force, OSD, DLA, and GIDEP.[30] The Teaming Group was developed as a means to implement some of the goals of the DoD DMSMS Working Group. The ACAT-ID Missile Pre-Production Program Manager will need access to the DoD Working Group either through the representative of the particular Service or through the DoD Teaming Group. The ACAT-ID Missile Pre-Production Program Manager will certainly want to become associated

30 DoD DMSMS Working Group Charter Rev 1; 7 Dec 99.

with and a member of the DoD DMSMS Working Group. Details on how the Program Office and Working Group interface appear in the next section.

The DMEA survey conducted in 1999, asked about specific changes in DoD policies and guidelines that, if implemented, would assist the Program Office in managing obsolescence. Specifically, they were asked "What specific changes in DoD policy or guidelines do you believe can help you better manage your obsolescence problems?" The program subject matter experts addressed many of the policy issues.

The following comments were made under the concept of using contracting as a policy change:[31]

> For at least the foreseeable future, provision needs to be made in the budget/POM process to enable PMs to fund, beginning in R&D, activities needed to develop the necessary processes, tools, design guidelines, cost prediction techniques, contract language, etc, that will enable them to proactively address the problem in concert with their contractors.
>
> To have contracts written that require the contracted company supplying the final production assemblies be more responsible for costs due to COTS obsolescence issues. As every 1 to 2 years, at least 5% of the parts used within a COTS product go obsolete; the contract should state that upgrades/regression testing be a responsibility of the production company so as to lower the chances of having hardware and software incompatibilities.
>
> The DoD should include DMS management in the Statements of Work; this should be a part of every contract.
>
> Acquisition reform needs to recognize the need to have contractual clauses addressing DMSMS. Also, budgets need to be established as a norm for obsolescence management and modernization upgrades. Programs should be required to have established DMSMS programs and plans. This needs to be a milestone requirement.
>
> Set up an on-going DMS program through the Logistics organization and make it an initiative in any military program. This should be in the initial Statement of Work for any new contracts. Contacts can be placed in the SOW and initiatives could be standardized in order to ensure the industry and Government work together and not compete against one another.

31 Defense Microelectronics Activity, DMSMS Survey Results; December 1, 1999, p. 15.

> Contract for DMSMS management plan and regular reporting of problems and recommended solutions. Eliminate Configuration control at piece part level. Allow more modernization through spares (color of money)

The use of guidelines and a management process to control obsolescence was also addressed with the following comments. [32]

> More directives and guidelines to manage obsolescence.
>
> Forget the policy & guideline documents. What we need is a culture change, which supports a design & development environment, which is prepared to deal with continuous technology refreshment.
>
> DoD should establish a common policy that forces each service PM to follow. If everyone follows the same policy, that would lead to many common solutions to our DMSMS problems.
>
> Changes in procurement practices are necessary to allow programs and contractors to have the long-term focus necessary to make the smartest DMS decisions. Yearly procurement is not the way! Need to maximize the level of information and data sharing between Users to allow most efficient use of DMS funding.
>
> DMSMS must be considered from "womb to tomb" (design, development, production, supportability). Obsolescence Management program guidelines are required, with room for Government, Contractor or Subcontractor versatility. DMSMS Program must be approved by the Customer.
>
> Funding for system (black box) managers/technical experts to acquire training, tools, analysis, testing, contract support, and parts to combat obsolescence
>
> DMS susceptibility should be a specific criteria evaluated in Design Reviews
>
> Most acquisitions are driven by the initial cost, not the life cycle cost. I would like to see a better appreciation of how spending a little more in up front costs (NRE) will greatly reduce the overall costs through the life of a system, in particular by focusing on increasing the use of common design standards within the DoD.

The comments made by the subject matter experts certainly affirms the use of a contract as a means to ensure that the contractor develops an obsolescence policy for the program. Using a contract is an excellent approach to resolving obsolescence issues that

32 Ibid.

include a requirement in the Statement of Work. The use of a contract makes it possible for the bidding contractors to propose an approach to minimize the impact of obsolescence occurrences during the life of the system.

The " Bona fide Need" rule is a policy that needs to be reviewed by the DoD. As seen below, the statute states that funds must be used strictly within the confines of the contract and contract period.

Statute 31 USC 1502(a)

> (a) The balance of an appropriation or fund limited for obligation to a definite period is available only for payment of expenses properly incurred during the period of availability or to complete contracts properly made within that period of availability and obligated consistent with section 1501 of this title. However, the appropriation or fund is not available for expenditure for a period beyond the period otherwise authorized by law.
>
> (b) A provision of law requiring that the balance of an appropriation or fund be returned to the general fund of the Treasury at the end of a definite period does not affect the status of lawsuits or rights of action involving the right to an amount payable from the balance.
>
> **Statute 31 USC 1341(a)** (a) (1) An officer or employee of the United States Government or of the District of Columbia Government may not - (A) make or authorize an expenditure or obligation exceeding an amount available in an appropriation or fund for the expenditure or obligation; (B) involve either Government in a contract or obligation for the payment of money before an appropriation is made unless authorized by law; (C) make or authorize an expenditure or obligation of funds required to be sequestered under section 252 of the Balanced Budget and Emergency Deficit Control Act of 1985; or (D) involve either Government in a contract or obligation for the payment of money required to be sequestered under section 252 of the Balanced Budget and Emergency Deficit Control Act of 1985. (2) This subsection does not apply to a corporation getting amounts to make loans (except paid in capital amounts) without legal liability of the United States Government.
>
> (b) An article to be used by an executive department in the District of Columbia that could be bought out of an appropriation made to a regular contingent fund of the department may not be bought out of another amount available for obligation.

The strict interpretation of the statute severely limits the Program Manager when an obsolescence issue arises. A pre-production missile program may call for only a few major end items to be manufactured and procured under a particular contract. Due to the complex nature of a missile program, the contract period for a limited quantity may last for a couple of years. During the contract period, the microcircuit manufacturer may discontinue a component or multiple components. In many cases, the Program Office is aware that it is very possible to have a follow-on limited quantity or that Full Rate Production will commence. With the "Bona fide Need" rule stating that appropriating components outside of the contractual time period the Program Manager is not authorized to procure a limited number of components to guarantee that a work stoppage does not occur between manufacturing runs. Without the authority to procure the critical components needed to ensure manufacturing ability, the Program may have to undergo an immediate redesign, lasting 18-24 months, before additional procurements can be made.

For the missile pre-production program manager under the MDA chain-of-command, the Missile Defense Agency Obsolescence Proposals should be implemented in a program fully funded by the MDA. These proposals, discussed earlier, can provide guidance and possibly be used as a policy for MDA programs. Certainly, a COTS Management Program and Technology Roadmap program is needed for pre-production programs. These programs used across complex programs will enable program offices to obtain technologically advanced products.

AMCOM can implement an Obsolescence Program that encompasses all weapon systems at Redstone Arsenal. With the impacts on both legacy and pre-production programs, cost avoidance can be calculated that would cover the costs of the mission-funded obsolescence program versus the Program Office-unique obsolescence plan.

D. DESIGN TECHNIQUES, ANALYSIS TOOLS AND OBSOLESCENCE MANAGEMENT APPROACH FOR A PRE-PRODUCTION ACAT-ID PROGRAM MANAGER

1. Design Techniques

An ACAT-ID program that has yet to go into production is the key point in the life cycle of the system to make the critical decisions that will affect the long-term costs associated with the program. The ACAT-ID pre-production Program Manager is in the position to influence the design of the system to mitigate obsolescence with microcircuit devices. The effort done prior to the design of a circuit, box, assembly, or system provides the best opportunity to implement techniques to mitigate potential future obsolescence issues.

The Program Manager must correlate the typical life cycle requirement of the Missile program versus the short life cycle of the typical microcircuit. From Figure 19, the short microcircuit life cycle presents obsolescence issues in the pre-production phase since the time associated with the selection of the microelectronic devices and the actual purchase and implementation of the hardware is potentially greater than the typical 18-24 month manufacturing window.

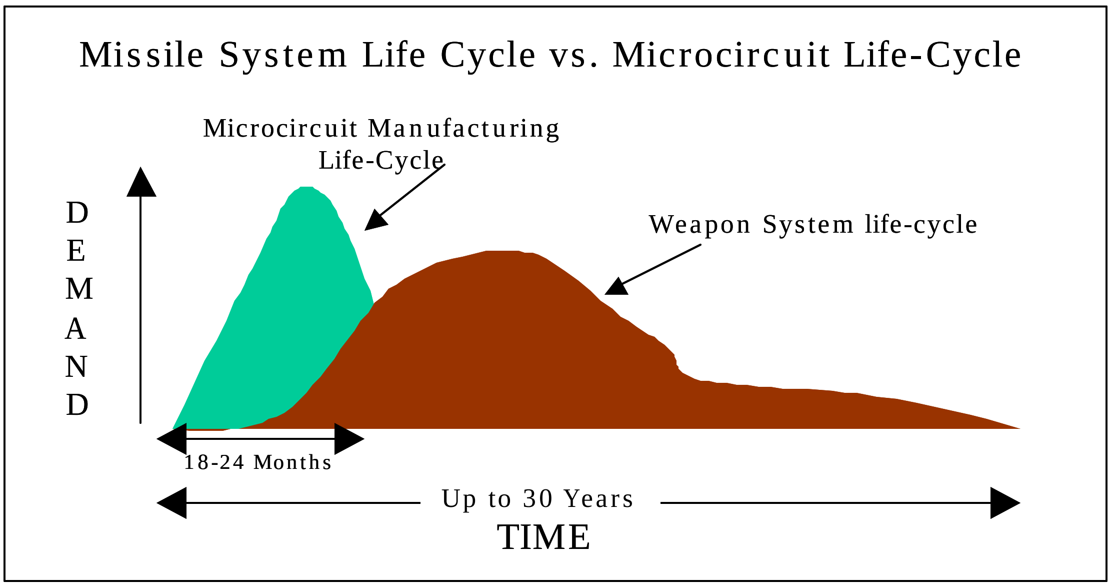

Figure 19. Missile System Life Cycle vs. Microcircuit Life Cycle.

As an obsolescence mitigating design tool, VHDL, provides accurate documentation of the digital electronic circuitry. The documentation provides valuable information when it is necessary to replace a microcircuit. The VHDL is a description language of the functions of the digital circuit. The language is synthesized into a software code that implements the circuit functions into a microcircuit array such as a Field Programmable Gate Array (FPGA).

The Program Office should conduct a comprehensive technology assessment that provides the insight necessary to maintain the ability to insert technology and perform product upgrades. With the rapid turnover and evolution of microcircuit technology in both the military and commercial industries, the assessment will determine both the maturity of the technologies used in the design and possible options for technology upgrades. The process of technology insertion has the potential for large cost and schedule impacts. However, with the use of analysis tools, it will be possible to predict the budget necessary for technology insertion and time for implementation.[33]

Technology insertion provides the opportunity to develop a new product, resolve obsolescence issues, and enhance performance. A program that has continual technology advancements reduces the logistic footprint and associated costs along with protecting the manufacturing source of the supplier implementing the new technology. When preparing for technology insertion, the PM must maximize the use of open system architecture to alleviate the reengineering and design costs associated with integrating the new technology into the larger system.

The PM must conduct trade-offs to determine whether the technology is technically and economically feasible. The trade-offs need to consider cost, schedule, logistics support, technical risk, and the ability to insert the technology on a large scale.

2. Analysis Tools

Many of the component analysis tools were discussed in Chapter III. The ACAT-ID pre-production program manager has the unique opportunity to influence the program through its entire life cycle. Steps should first be taken to develop a preliminary circuit design that selects microcircuits from a qualified part supplier. This component supplier or manufacturer should be qualified as a preferred provider based on quality, reliability, and past delivery timeliness. The list of components should be submitted to GIDEP, and other previously described databases, for evaluation of potential obsolescence impacts. The parts list should then be revised with the results obtained from the database tools and GIDEP.

The ACAT-ID Program Manager does not necessarily require a suite of analysis tools that track the system logistics trail or production quantities. Rather, the PM needs a tool that analyzes the component availability of the devices used, the technology and

33 DMEA Program Managers Handbook Common Practices, pp. 3-21, May 31, 2000.

technology maturity of the microelectronic devices, and the projected life cycle of the components.

3. Management Approach

Two segments are involved in the management approach for an ACAT-ID pre-production missile program. The first part of the management approach is the implementation of contract language that ensures that the contractor is capable of meeting contractual obsolescence responsibilities; the second is the engineering approach. The Program Manager must avoid the common prevailing thought that, since the system is still in design, a need does not exist for an obsolescence program or that logistics will handle obsolescence issues when they eventually occur.

a. Contractual Language

For a program that is not yet in the long-term production phase, the contract period can be relatively short. A missile contract may call for only a few prototype or production-representative end items. In such situations, the PM and contractor may only wish to address obsolescence issues as they affect the term of the contract. While this approach may satisfy the limited number of production items required, it can leave the missile program in an obsolescence situation that prevents the program from completing the next phase of the system life-cycle. Rigid "color of money" policies established by Congress, in particular Title 31 United States Code, Section 628, states that the funds appropriated by Congress must be applied only for the purposes authorized for appropriation.[34] A program that is building three missiles, for example, in a Low Rate Initial Production (LRIP) contract, is not authorized to buy components for missiles anticipated in a follow-on LRIP contract or full rate production. Advanced procurement can be authorized on a case-by-case basis. Although the phases may overlap or the dividing lines may not be clearly indicated, procurement funds may not be used for the research of an obsolescence issue.

For the program in the conceptual phase of development, the contract language should focus on providing an incentive to use obsolescence mitigation techniques to influence the product design and to design and develop a support system.

34 DMEA, DMSMS Acquisition Guidelines - Implementing Parts Obsolescence Management Contractual Requirements, December 2001, p. 2-8.

Title 10USC2440 requires an Industrial Capability Assessment to be completed by the Program Office at each milestone to determine the industrial capability to design, develop, produce, and support the system. The development phase of the system life cycle should address the risk mitigation techniques. The obsolescence requirements should be included in the Request for Proposal (RFP), whether the obsolescence requirement is preliminary or detailed, in order to allow the contractor to bid against it.[35]

In a contractual Scope of Work (SOW) or Statement of Objectives (SOO), the Program Manager is allowed to state the requirement for obsolescence management. Section L of the contract requests information on how the offerer will execute the obsolescence requirement and Section M describes how the proposal will be evaluated. The following example describes potential contract language:[36]

SOO or SOW	Section L	Section M
The contractor shall establish an implement a parts obsolescence program	The offeror shall describe how their obsolescence program will reduce the impact of Obsolescence.	The offeror's approach for parts obsolescence management will be evaluated for best value in terms of technical approach and cost, with additional consideration for past performance and cost avoidance.

Table 10. Potential Contract Language.

b. Engineering Implementation

The ACAT-ID pre-production Program Manager should assign an obsolescence focal point to serve the interests of the missile system under development. Program and product offices may be relatively small for a pre-production program in Concept Exploration, EMD, or LRIP. Therefore, the system focal point may have multiple responsibilities. Ideally, this individual would have an interest and/or background in obsolescence issues. Even though obsolescence affects materials as well as electronic components, the overwhelming turnover in electronics necessitates that this individual have some experience with microelectronic devices.

35 Ibid, p. 3-3.

36 Ibid, p. 3-9.

The system obsolescence focal point is responsible for informing the program office and the product IPTs that microcircuit obsolescence is a growing problem and that mitigation features can be designed into the system and resolution plans developed in the case of an obsolescence issue. With the support of the Program Manager, the system obsolescence focal point should develop a system obsolescence management plan. As part of the management plan, obsolescence analysis should be included in the various types of program design reviews. The various IPT's and their members should be encouraged to provide insight into the obsolescence management plan, since a key element of the Integrated Product and Process Development (IPPD) process is to use various people with different perspectives and skills.

The individual should coordinate with the AMCOM Electronics Analysis and Prototyping Group office for in-depth assistance from the subject matter experts. It is not necessary for the ACAT-ID pre-production missile program to be located at Redstone Arsenal for the AMCOM Electronics Analysis and Prototyping Group to provide obsolescence support. The missile system focal point should also coordinate with GIDEP and the DoD DMSMS Teaming Group in order to become part of their process to assist the Program Offices at no cost to the PM. Coordination with other obsolescence subject matter experts allows the Project Office focal point to stay abreast of the latest resolution opportunities and mitigation plans, even when the focal point has other responsibilities. The figure below demonstrates the interface between the Missile Program Office and the DoD DMSMS Teaming Group.

The parts list for microelectronic devices should be standardized so that the various obsolescence analysis tools discussed earlier can screen for the components. Most of the obsolescence analysis tools, such as GIDEP, MTI-AVCOM, Parts Plus, Tactrac, and IHS, base their analysis on generic industry part numbers and cannot differentiate program-specific part numbers.[37] Part lists should be generated to include the manufacturer's part number, generic part number, system or contractor-unique part number, and NSN as necessary.

37 DMEA Common Practices, p. 3-3.

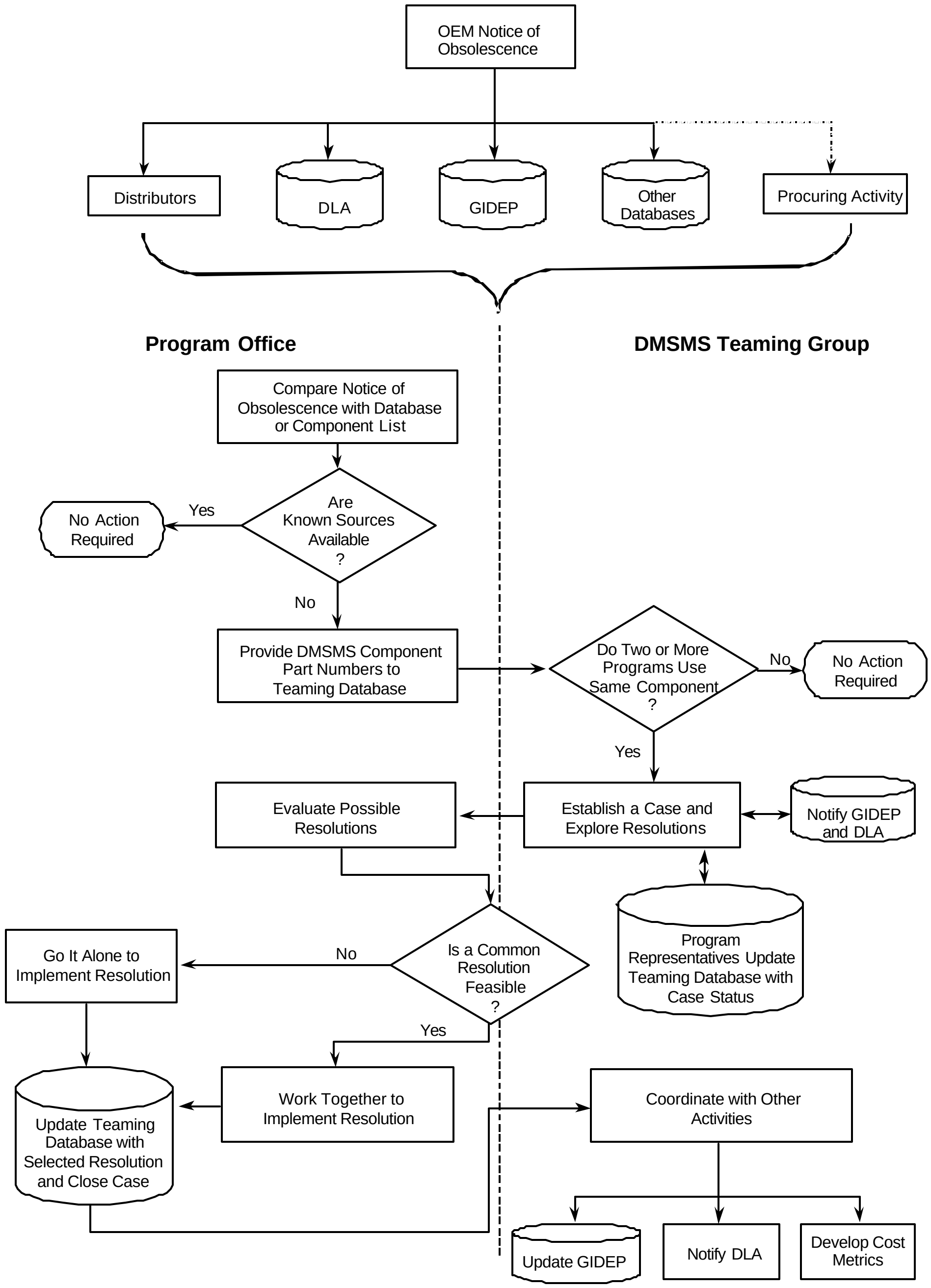

Figure 20. DoD DMSMS Teaming Group’s Interface with the Program Office.

The first priority for the Program Office should be to ensure that obsolescence is not being designed into the system. The design engineers are to be responsible for the design life expectancy, technology life expectancy, and developing an obsolescence risk assessment for COTS components. The component engineers have the additional responsibility of analyzing individual components and contacting component manufacturers for new and alternative products.

An obsolescence management plan is possible in all phases of the weapon system life-cycle. The management plan must include provisions for the upgrade and added system functionality. It must be expected that opportunities will become available to improve the functionality, if and when, the current design becomes obsolete. The parts list must be constantly screened for obsolescence impacts and out-year predictions. The management plan should define a cut-in point for hardware upgrades based on the out-year component availability predictions during the design phase.

The use of custom-built microcircuits, such as Application Specific Integrated Circuits (ASIC), are unavoidable using VHDL, as was described earlier, and mitigates the risk. As part of the management plan, the issue of spares needs to be addressed to ensure availability in the post-production phase of the program.

E. COST/BENEFIT ANALYSIS OF PROPOSED OBSOLESCENCE MODEL AND ANALYSIS TOOLS

The benefit of having a proactive microcircuit obsolescence program and the cost associated with the funding of the program can be matched against not having an obsolescence program. The obsolescence problem is never going to be solved. Rather, the effects of obsolescence can only be managed.

The AMCOM Electronics Analysis and Prototyping Group has been provided many Program Offices with proactive analysis and resolutions to the impact of potential serious obsolescence issues. Several benefits of proactive obsolescence management are listed in the table below.

Issue	Solution and Benefit
Environmental Control Unit (ECU) / Prime Power Unit (PPU) design incorporated obsolete controller	Source identified for a "form / fit / function" equivalent ECU / PPU controller. Benefit- Avoided redesign of Environmental Control Unit / Prime Power Unit (Estimated $ 200 Thousand cost avoidance)
Contractor requested $12M to perform life buy of obsolete processor. AMRDEC research identified more suitable replacement processor based on technology.	ECP submitted with technologically viable processor and removal of obsolete memory chips at cost of $4M Benefit- $8M Cost savings and the Reduction of microelectronic devices used on the CCA
Contractor requested $5M for	Contract award of ~$3M for obsolescence

obsolescence solutions AMRDEC analysis of microelectronic technology used in M270A1 and application of DoD developed cost resolution factors calculated average potential cost due to obsolescence at $2.44M	solutions. Benefit - $2M Cost savings
Linear Technology discontinuance affected 3 components used in production design	AMRDEC negotiated extension of life buy date with LTC to procure components to complete production. Avoided minor CCA redesign involving re-layout. Benefit - $1.3M Cost avoidance

Table 11. AMCOM Cost Avoidance Examples.

As seen from the table above, having an obsolescence program in place is critical in proactively mitigating impacts rather then causing a work stoppage in order that a full redesign can be accomplished and implemented.

The Defense MicroElectronics Activity (DMEA) developed a cost avoidance matrix that detailed the average cost avoidance based on various resolutions.[38] To figure the cost avoidance, the resolution option used to mitigate the obsolescence issue is subtracted from the next higher resolution option. In many cases, the next higher resolution option may not be available so further cost avoidance averages can be calculated. The point of the Cost Avoidance Values is that a proactive obsolescence management plan can pay for itself with just a few successes.

Many of the tools detailed earlier in the thesis can also be analyzed for cost verses benefits. Some of the tools are free and do not require Program Office funding, but benefit the program office. These tools are the GIDEP obsolescence analysis tool and the DoD DMSMS Teaming Group. The Program Office will need to appoint a delegate to interface the programmatic issues, but no other funding is necessary.

Resolution Option	Average Resolution Cost	Average Cost Avoidance
Existing Stock	$ 0	$ 1,884
Reclamation	1,884	4,500
Alternate	6,384	11,727

38 Defense MicroElectronics Activity; Resolution Cost Metrics for Diminishing Manufacturing Sources and Material Shortages, December 31, 2001.

Substitute	18,111	29,249
Aftermarket	47,360	20,652
Emulation	68,012	43,022
Redesign- Minor	111,034	299,118
Redesign- Major	410,152	0

Table 12. DMEA Cost Avoidance Values.

Some of the tools reviewed earlier have a cost associated with their use in the form of subscriptions or computer hardware or both. Some of the tools with the various options can be expensive. The pre-production program manager is focused on the development of the weapon system that incorporates state-of-the-art electronics. Many of the tools involve heavy concentration on configuration management. The use of performance specifications precludes the delivery of a Technical Data Package (TDP) that contains the entire system decomposition for new missile weapon systems in development. The use of Program IPTs can assist in the exchange of component information and Program Office insight into the components being used. The pre-production missile program manager will need to be open to funding a robust obsolescence analysis tool whether in the Program Office or through the contract to the prime contractor since the focus is on a pre-production missile weapon system.

One of the proposed modifications was the mission funding of the AMCOM Electronics Analysis and Prototyping Group by the Army, DoD, or a combination of both. MDA has assembled a set of proposals to cover MDA programs using the AMCOM Electronics Analysis and Prototyping Group obsolescence function. The various obsolescence tools necessary to maintain a quality obsolescence program for the obsolescence issues dealt with at Redstone Arsenal are estimated to be $750K per year in 2002 dollars. The personnel costs would run approximately $2.25 million for a staff of ten engineers, two supervisory levels, support staff of ten people, and an administration staff. Thus, the entire obsolescence program cost estimate would be $3.0 million in 2002 dollars. For additional and unique Project Office obsolescence support, the Program Manager would need to fund the AMCOM Analysis and Prototyping Group. The Department of the Army can implement the same type of obsolescence program with all its major commodity commands.

As mentioned earlier, the funding of an obsolescence management program is a "pay me now -or- pay me later" principle. The ACAT-ID Pre-production Program Manager needs to make the decision on whether or not to have an obsolescence management program. Then, if the PM decides to have an obsolescence management program, it needs to be decided whether the initiative is adequate to cover the needs of the program. The PATRIOT Missile Project Office (PPO) had funded a small obsolescence level of effort for many years that looked at the logistics five-year projections of microcircuits to be procured. Over a period of time, obsolescence became a major factor due to field repairs and the need for new circuit cards. Since many of the assemblies were stocked at the assembly level, there was no visibility into the individual components used. The arrangement was just a reactionary system. The Program Manager, through the Production Division, funded an Obsolescence Management IPT. The IPT coordinated the efforts of the prime contractor, Raytheon, and the Government functions located at the PPO, AMCOM, Letterkenny Army Depot, and Ft. Bliss. The IPT had Team Functions, Government Functions, and Contractor Functions as listed in the table below.

Team Functions	**Government Functions**	**Contractor Functions**
Government and Contractor Manage Obsolescence as a coordinated team Continually Refine the Obsolescence Program With New Tools, Processes, and Management Initiatives Share Parts Lists, Databases, and All Obsolescence Information, Support Evaluation of Proposals and Contract Changes (ECPs), Combine Skills and Abilities for Optimum Effectiveness, Kept	Maintains a database using multiple obsolescence tools, both commercial and Government, to assist in the obsolescence effort. Analyzes the 5-year spare buy requirements from IMMC to identify obsolescence issues. Reviews notices from the Government Industry Data Exchange Program (GIDEP) and Manufacturers obsolescence alerts.	Coordinates the obsolescence activities across all Raytheon internal operations. Analyzes information requests from the PPO on obsolescence issues that are tasked to Raytheon. Assists in making more accurate schedules and contract proposals. Maintains and updates PATRIOT Master Obsolescence database.

abreast of market direction Work with FMS Customer(s) on Obsolescence and Resolution Recommendations Proactively Perform Assessments and Reviews for Obsolescence Avoidance	Maintains Government interface with other Govemment obsolescence groups such as Department of Defense (DoD) Diminishing Manufacturing Sources and Material Shortages (DMSMS) Team. Interfaces with IMMC and Acquisition Center on Information Requests.	

Table 13. PATRIOT Obsolescence IPT Team Functions.

The Obsolescence IPT was funded at a level of effort of approximately $450K that was divided between Raytheon and the AMCOM Obsolescence Group. The IPT began to pay immediate dividends.

- A total of 4 components had adverse impacts to the Launcher. Initially, a major redesign was considered but a new manufacturing source was developed for the components. A cost of $750K was avoided to develop a new source versus circuit card redesign. Replacements for all four were determined.
- On a particular circuit card, two components were determined to be obsolete. In both cases, a new source was developed, avoiding a redesign and possible field down-time due to the lack of spare parts.

The AMCOM Obsolescence Group was working with Lockheed Martin Fire Control Systems in Dallas on the PATRIOT Advanced Capability-3 (PAC-3) Missile while the PAC-3 program was still in EMD. The proactive teaming arrangement analyzed the components used, determined obsolescence issues, developed resolutions, and avoided a shutdown in EMD. This was accomplished by:

- Buying components avoided a Master Frequency Generator (MFG) redesign in EMD. The redesign cost of $1.5 million and a 15-month schedule slip was avoided in EMD. The MFG still has to be redesigned but there is no schedule cost.
- A cost of $2.1 million and 24 months schedule slip was avoided in EMD for the Radio Frequency Data Link (RFDL). The RFDL still has to be redesigned, but this will occur at a later date.
- A cost of $650K and 9 months schedule slip were avoided in EMD for the GPU. Since an immediate redesign was not necessary, sufficient time was allowed to find a replacement part. Redesign has been avoided. A cost of $850K and 14 months schedule slip was avoided for the Enhanced Launcher Electronics System (ELES). A buy was done for future system

requirements of all systems. The ELES will not have to be redesigned for this part.

Without a proactive obsolescence management program, the PAC-3 system could have faced huge redesign costs along with the associated test and evaluation that would have been required for a redesign.

The Program Manager can choose not to fund either an obsolescence management program or an obsolescence analysis tool, but then the risk remains of being overwhelmed by having to pay for resolutions due to obsolescence issues.

F. PLANNING FOR OBSOLESCENCE IN THE MISSILE ACAT-ID PROGRAM OFFICE

Planning for obsolescence is first recognizing that obsolescence cannot be prevented, but only managed. The implementation of an obsolescence plan for a Missile ACAT-ID program is most effective when the plan is introduced into the earliest stages of the program life cycle. An obsolescence plan and obsolescence avoidance begins with the preparation of design documentation. During the design phase, managing the risks of obsolescence are the responsibility of both the design activity and the component engineering and analysis teams.

The formation of a program-level IPT maybe necessary for an ACAT-ID program where a program-level obsolescence IPT is created to manage obsolescence issues throughout the program. The IPT would be responsible for developing a program-wide obsolescence management plan and for ensuring that all the Government and contractor design groups and subcontractors have the processes in place to meet the requirements of the obsolescence plan. The program would determine who would be members of the obsolescence IPT, but it should be cross-functional. It is important to ensure that the interests or expertise of the following functions are represented or used. The composition and leadership of the obsolescence IPT should change as the program advances in the weapon system life cycle.[39]

The obsolescence IPT should create the procedures to initiate an obsolescence study analysis, when and if an issue arises. The obsolescence IPT would be responsible

[39] Tanemura, Steve, Guidance for Part Obsolescence Management Plans, Boeing Document, Phantom Works, Central Parts Engineering – Puget Sound, November 29, 1999, Section 3-1.

for determining which options should be considered for the program. All potential solutions to an obsolescence issue should be analyzed for implementation. Each obsolescence analysis should consider all factors that influence the final decision. The obsolescence IPT would be responsible for developing a set of criteria and guidelines that can be referred to when performing the obsolescence analysis. The obsolescence IPT may provide decision-making flow charts or lists of risk factors that can be used to evaluate various obsolescence resolution options.

The program office should have an obsolescence component database that holds all program-specific information related to obsolete parts. These databases should be configured such that each program can access information in other program's databases. The relevant databases were discussed earlier.

In the initial part selection process, all parts selected for the design should be evaluated and assessed for the risk of potential obsolescence. Standardizing on a minimal list of preferred or prior-approved parts should help constrain the cost of this DMS evaluation process. This listing should be updated frequently. For parts that are both critical to the design and susceptible to obsolescence, the projected technology evolutions need to be developed and understood. In addition, the design activity should accommodate design features to ease the insertion of newer technology parts at selected phases during or following system production.

In the design, the insertion of replacement parts could occur any time. The most effective insertion plan is to coordinate the expected part phase-out with future resources allocations for planned upgrades or performance enhancements. When an opportunity is discovered for technology insertion, the associated risks and decision process should be documented as a proposed design change. In the early conceptual and preliminary designs, consideration should be identified to proactively mitigate obsolescence issues.[40]

Microcircuit obsolescence monitoring is necessary to stay on top of obsolescence impacts. GIDEP has an automated parts matching service at no cost to the program. The Program Office obsolescence IPT can submit their parts list that will be compared to the GIDEP database to determine if there are any obsolete parts reported against it. A report

[40] Ibid, Section 3.2.

is then returned to the Program Office showing any obsolescence impacts against the parts list. This automated parts matching process can be compared once or at regular intervals defined by the program office.[41]

The Program Office takes a proactive step in mitigating obsolescence when the obsolescence IPT takes the necessary steps to develop or subscribe to an obsolescence prediction tool or tools. The various tools were described earlier. With the rapid turnover in technology occurring every 18-24 months, the prediction tool projects what devices may become obsolete. Another element in using prediction tools is to identify how the piece-part obsolescence problems affect the next higher assemblies, such as a circuit card or other line-replaceable units. This is achieved by developing a process that periodically reviews the list of parts used by the program for potential obsolescence. The prediction information changes with technology roadmaps and market demand fluctuations of a particular device.

The Obsolescence IPT should develop an obsolescence resolution process that has a documented process for resolving obsolescence issues. Once an obsolete part has been identified, the obsolescence IPT should verify this information with the device manufacturer and identify where the device or devices are used in the system. The manufacturer may provide information useful in assessing obsolescence resolution options, which could include the cutoff date for the last time buy. The obsolescence analysis of the component to be discontinued must include the following examinations:

Part Usage	The total number of parts needed to support the entire life of the product or to cover a specific period of time.
Cost and Schedule	All potential costs to implement a given solution are considered along with a schedule to implement the resolution. High cost solutions, like redesign, may need to be deferred to a later contract phase.
Current inventory	Current inventory of the obsolete part can influence the decision-making process by extending the date when parts will no longer be available to the factory or depot.
Long-Term Product Strategy	Equipment that must be supported for 20 years will have different requirements than equipment nearing the end of its

[41] Defense Electronics Agency, Program Managers Handbook: Common Practices to Mitigate the Risk of Obsolescence, May 31, 2000, p. 3-11.

	life.
Contractual Obligations	Contractual obligations, warranties, or restrictions must be considered
Predicted Obsolescence	DMS potential of the remaining components on the circuit card or other next higher assembly.
Performance Impact	Performance enhancements due to the insertion of new technology devices or redesigns

Table 14. DMS Trade Studies[42].

Once a device has been determined to be obsolete or will soon be discontinued by the manufacturer, the Obsolescence IPT resolution process needs to reflect the options in Table 15 seen below.

The Obsolescence IPT should develop a Technology Roadmap. A technology roadmap is a business plan for the future of a part, material, or circuitry such as a microprocessor. The technology roadmap involves a time-phase for upgrading performance and it may include a change in the form and fit of the device. The technology roadmap plans for Technology Insertion, the introduction of a new part that uses advancement in technology replace the part currently in the design. With the technology roadmap leading to and planning for technology insertion, obsolescence impacts can be mitigated with the analysis of technology trends and the emergence of new technologies.

Alternate Source	An alternate source is defined as another manufacturer that makes the same part with the same generic part number and that meets all specification requirements of the obsolete part for Form-Fit-and Function (FFF).
Extend Production:	Negotiate with the manufacturer to continue supplying the part for the life of the program
Lifetime Buy or Life-of-Type Buy	Procurement, of a known end-of-life part, that is intended to cover a specific period of time after which a permanent solution will resolve the DMS problem
Bridge buy	Procure parts to cover a set amount of time sufficient to bridge to when a more permanent DMS solution is implemented.
After-Market	A supplier purchases the mask sets and/or other equipment

42 Tanemura, Section 3.4.3.

	and process data from the original part manufacturer after a device has been discontinued then manufactures the wafers that allow a FFF replacement
Develop a New Source	Development of a new manufacturing source to supply the FFF replacement component.
Emulation	Creating a FFF replacement for the obsolete part using state-of-the-art materials, design, and manufacturing techniques.
Substitute Part	A part whose performance may be less capable than the one specified for one or more reasons (e.g., quality or reliability level, tolerance, parametrics, temperature range. But the part possesses the functional and physical characteristics capable of being exchanged with the design part only under specified conditions in particular applications. Although not FFF equivalent, it suffices for the application.
Design a Custom Device	Design of a custom device, such as an ASIC, gate array, or programmable logic device, to replace the DMS part.
Redesign	Design Obsolete Components out using a new design.
Reverse Engineer	Creating a functional replica of the DMS device based on the review of existing technical data, test, and physical analysis

Table 15. Resolution Options[43].

G. CHAPTER SUMMARY

In order to gain a perspective concerning how the DoD can deal with the rapid turnover in microcircuits, the techniques that the commercial airline industry utilizes in handling obsolescence were analyzed. To effectively deal with the rapid turnover in electronics, various changes that the DoD could institute were evaluated. Various policies on restructuring the DoD and AMCOM obsolescence efforts were detailed on how to assist the Program Manager in dealing with the impact of obsolescence. The various obsolescence analysis and mitigation tools available to the ACAT-ID Missile Program Office were analyzed for their impact on how to mitigate obsolescence. The Program Office can use design techniques to assist in the mitigation of obsolescence. The cost-benefit of having or not having an obsolescence program was evaluated in light of the consequences of not having a program to mitigate obsolescence impacts. Manufacturers have experienced a rapid rate of obsolescence of microelectronic devices over the last decade and multiple weapon systems have been impacted. The planning for

[43] Ibid, Section 3.4.3.

obsolescence in a pre-production ACAT-ID missile weapon system program was discussed.

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V. CONCLUSIONS

A. CONCLUSIONS

All of the stated objectives were analyzed and reported. The AMCOM obsolescence program conducted by the Air and Missile Research Development and Engineering Center, Engineering Directorate, Manufacturing Science and Technology Division, Electronics Analysis and Prototyping Group, was analyzed to illustrate how it presently supports the missile program offices at Redstone Arsenal. The tools and processes used by AMCOM to mitigate the growing microcircuit obsolescence problem were discussed in detail. The airline industry provided an excellent comparison with the DoD ACAT-ID missile pre-production weapon systems in demonstrating how a large private industry handles microcircuit obsolescence. Various obsolescence prediction tools and design techniques were analyzed and discussed along with the methods ACAT-ID missile program offices were using to deal with impacts caused by obsolescence. Various DoD initiatives were also discussed and analyzed.

B. RECOMMENDATIONS

The DoD and/or the Army should establish a permanent obsolescence group to assist Program Managers in mitigating obsolescence and should fund the AMCOM Electronics Analysis and Prototyping Group. The funding would include the requisite subscription tools and databases necessary to perform the mission.

The MDA obsolescence initiative should be instituted as a joint effort between MDA and AMCOM to provide a single process initiative for all missile weapon systems. In addition, the initiative to manage COTS items should be implemented along with a technology roadmap in order to predict what technologies will be available when a missile system assembly goes into production.

The ACAT-ID pre-production missile system Program Manager should establish an obsolescence working group between the PMO, contractor, and the AMCOM Electronics Analysis and Prototyping Group. This group will tract components for obsolescence impacts, suggest design changes to mitigate obsolescence, and provide education and training to all the design and element IPTs.

The ACAT-ID pre-production missile system Program Manager should enter into a teaming relationship with the AMCOM Electronics Analysis and Prototyping Group to establish the necessary obsolescence predictions in order for the PM to establish a funding line to deal with projected obsolescence impacts. If the PM does not team with AMCOM, then the PM should fund a contractor such at MTI, TACTech, or Arinc to perform out-year funding projections.

The ACAT-ID pre-production missile system Program Manager should use the DoD initiatives and programs that are provided at no cost to the PMO. The PM should become a member of the DoD DMSMS Teaming Group to establish a presence and forum to discuss common obsolescence issues and solutions across multiple programs. The PM should also team with GIDEP and use their database to receive alert notification on components schedules to be discontinued by the manufacturer.

C. SOLUTIONS

Implement a DoD and/or Army permanent obsolescence group equipped with the necessary tools, databases, engineers, support staff, and funding to assist Program Managers in mitigating obsolescence.

Implement the MDA obsolescence initiative. This joint effort between MDA and AMCOM will provide a single process initiative for all MDA systems. In addition, the initiative will manage COTS items and establish a technology roadmap to predict which technologies will be available in the future.

For the ACAT-ID pre-production missile system, the Program Manager should implement and fund an obsolescence working group between the PMO, contractor, and the AMCOM Electronics Analysis and Prototyping Group. This group will track components for obsolescence impacts, suggest design changes to mitigate obsolescence, and provide education and training to all the design and element IPTs.

For the ACAT-ID pre-production missile system, the Program Manager should implement and fund the AMCOM Electronics Analysis and Prototyping Group to provide the PM with out-year obsolescence predictions in order for the PM to establish a funding line to deal with projected obsolescence impacts. If the PM does not team with

AMCOM, then the PM should fund a contractor such at MTI, TACTech, or Arinc to perform out-year funding projections.

For the ACAT-ID pre-production missile system, the Program Manager should join the DoD DMSMS Teaming Group and establish a working relationship with GIDEP.

D. PROPOSED FURTHER RESEARCH

Research the cause, effect, and cost benefit analysis to the MDA Obsolescence initiative. At present, MDA is proposing to fund the majority of this effort and the return on MDA's investment should be analyzed.

The Medium Extended Air Defense System (MEADS) is a joint international co-development missile weapon system program between the US, Germany, and Italy. An investigation should be performed in order to establish procedures, plans, objectives, and finally the implementation of an obsolescence program across all three countries.

The AMCOM Integrated Material Management Center (IMMC) is the logistical support center for many legacy systems. An obsolescence program should be researched and implemented for the mitigation of obsolescence in fielded systems.

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